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# A STUDY OF THE HISTOLOGICAL STRUCTURE OF MOUSE OVARIES FOLLOWING EXPOSURE TO ROENTGEN IRRADIATION*†

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## INTRODUCTION

THE contribution presented before the Würzburg Physico-Medical Society by Professor Wilhelm Konrad Roentgen in 1895 on "A New Form of Radiation,"[1] opened a vast field for physical and biological investigation and introduced a valuable diagnostic and therapeutic agent, the ultimate importance of which is still unknown. Early investigators were especially interested in the physical nature of these "roentgen" or "x-rays" and their chief concern lay in the details of physical properties, production of more refined apparatus and the application to diagnostic medicine. No particular emphasis was placed on the biologic effects produced by this new form of radiation until a dermatitis and temporary sterility was noticed among the more active workers. The occurrence of these visible biologic reactions and the realization of the possibilities for beneficial effects which might be brought about by their proper application, has led to the extensive development of the present day in the field of roentgen therapy.

[1] English translation: Appendix A, *The X-Ray*, by W. J. Morton and E. W. Hammer, N.Y. American Technical Book Co., 1896.

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The biologic action of this invisible and penetrating radiation has not been easy to determine. The partial stability of results which soon built up around the investigations dealing with physical properties of the x-rays has never been as satisfactorily attained in the biologic field, although various approaches have been made and extensive work has been done to obtain definite biologic results by means of definite physical application of the radiation.

Using a variety of material which ranges from the gametes of the lower organisms to the viscera of the human (Dorland and Hubeny, 1926) each group of workers has attempted to build toward a factor of certainty in a particular field. Considering the factors of species and individual biologic variations, and the continuous state of flux which modify the environment of the individual, it is perhaps evident why much difficulty is encountered in correlating results or formulating definite laws to explain the biologic reactions to such a physical agent.

It is the object of this investigation to study the nature of the roentgen effects from the standpoint of structural changes produced in the generative glands of female house mice of a closely inbred strain.

## HISTORICAL

Literature pertaining to the influence of roentgen rays on living tissues has become quite extensive during the thirty-three years which have elapsed since Professor Roentgen's publication. Reports of observations on the reactions of mammals followed closely on the discovery of the x-rays, so that as early as 1897 Tarkhanoff reported paralytic conditions following long exposures, while Rodet and Bertin-Sans (1898) substantiated this observation. These authors, as well as Rollins (1901) and Warthin (1906), found that death followed exposures of long duration. Warthin also observed a destruction of lymphoid tissue of the spleen with toxic symptoms increasing proportionately with the tissue loss. He noticed a difference in the sensitiveness of male and female animals, of mice and rats, of animals of different ages and of individuals of the same species.

Heineke (1904) found that smaller mammals like mice, guinea pigs and rabbits died in from seven to eleven days following exposures of several hours. His histologic study showed excessive pigmentation of the spleen, a disappearance of splenic follicles and a widespread rarefaction of the cellular elements of the splenic pulp.

Bergonié and Tribondeau (1904), working with rabbits, showed that mammalian eggs were susceptible to roentgen rays, while primary follicles of the ovary were more easily acted upon than follicles in the older stages. Specht (1906) also found this difference in susceptibility among the ovarian follicles of the rabbit.

Bergonié, Tribondeau and Récamier (1905) reported the action of the roentgen rays on four rabbits in which they found a reduction in size of the irradiated organs. In a histologic study of the glands of the three animals which had received the smaller doses they found fewer primordial follicles than were usual and the normally existing hyaline clumps were apparently more numerous. In the animal receiving a relatively large dose the hyaline clumps were distinctly more numerous after the irradiation, and the interstitial tissue not changed in structure but less abundant.

Halberstädter (1905) found a reduction in size of the irradiated ovaries and found the ovaries more sensitive to the rays than were the skin or testicles.

Bouin, Ancel and Villemin (1906), while working on the physiology of the corpus luteum in rabbits, were the first to show that an obliteration of the graafian follicles can be caused by roentgen rays while the interstitial cells remain intact. In 1907 these same authors observed a disappearance of follicles in rabbit ovaries following roentgen irradiation. In these animals the interstitial gland made up nearly the entire substance of the whole organ.

Bergonié and Tribondeau (1907) found

that after irradiation the total interstitial tissue of rabbit ovaries was diminished. The nodules became more separated, with individual cells shrunken and their nuclei angular. This was thought to be due to a destruction of the theca interna and not a direct roentgen effect on interstitial tissue.

Lacassagne (1913) stated that the want of agreement in results obtained by the various authors in their experimentations with roentgen rays was due to differences in technique of irradiation; differences in species, age and size of animals; differences in time between irradiation and histological examination. He believed that the sensitiveness of ovarian follicles varied with the degree of their development.

Regaud and Lacassagne (1913), in studying the effect of roentgen irradiation on rabbit ovaries, found that the ova of the primary follicles degenerated in from fifteen hours to four days. Those follicles which remained at the end of the first week after irradiation were believed to have escaped injury. They observed that the oocytes degenerated and were absorbed about the seventh day. In follicles of from two to four layers, follicle cells were found to penetrate into the oocytes as they degenerated. The nuclei remained separate, the cytoplasm fused and giant multinucleated cells appeared in the stroma. These cells were seen to autolyse in from ten to fifteen days. In many-layered follicles the nucleus of the ovum sometimes appeared divided and the cytoplasm segmented. The follicular cells were seen to degenerate more rapidly and to disappear in two to four weeks. In mature follicles the nuclei showed degeneration, polar body formation and segmentation. The follicular epithelium was entirely destroyed, the theca cells underwent degeneration and were removed by the polymorphonuclear leucocytes. After three months new interstitial tissues formed from the cortical connective tissue.

Steinach and Holzknecht (1916) in irradiating two to four weeks old virgin guinea pigs, found the follicles completely atrophied and the contents shriveled to necrotic masses or hyaline lumps. The stroma was an unbroken mass of female "puberty gland" with lutein cell characters and, in part, rich in fat particles.

Béclère (1922) found that it was the destructive action on the ovaries which caused the arrest of uterine hemorrhages.

Matthews (1924) reported the histological effect of radium rays on the human ovary, reviewing the main histopathological changes as reported by Reifferscheid, M. Fraenkel, Danyan, Siegel, O. Hertwig, Regaud and Lacassagne, Weiss and Maury.

Briefly, these changes were round cell infiltration, engorgement of the old blood vessels and an extensive fibrosis in and about them and throughout the entire organ, with more or less disintegration of the follicular apparatus. These changes were found to increase in extent proportionately with an increase in the dose administered, so that finally there was a complete destruction of all the follicles (ripe and unripe) with an extreme fibrosis throughout the entire organ amounting in many of the blood vessels to obliterative endarteritis.

The re-establishment of fertility after a temporary period of amenorrhea is explained as being due to the fact that many of the ova are not destroyed by the radiation, but are imprisoned in the resultant tough, hard, fibrous tissue and cannot easily rupture.

The graafian follicle was found to be most vulnerable, while the germinal epithelium and corpus luteum were most resistant to the radiations. (This resistance of the corpus luteum is thought to make the radiation menopause less severe than the surgical.) Germinal epithelium was partially desquamated or absent, while young and old follicles were partially or wholly degenerated, filled with hyaline substance and swollen follicular cells, with no ovule or egg cell present. The cortex was found to be free of follicles and more or less densely infiltrated by fibrous tissue. All these changes were found to be proportionate to the amount of radiation.

Matthews believes the clinical and experimental evidence sufficient to show that age plays an important rôle in the final effects of radiation upon the ovary and he cites M. Fraenkel's study (1914), in which it was shown that a young, active guinea pig's ovaries, when irradiated with a sufficient dose of roentgen rays to produce sterility in an older animal were stunted in their growth but were not rendered sterile.

Snyder, Schneider and Little (1924) who had previously observed abnormalities in the descendants of roentgen irradiated mice, exposed a second group of mice to a similar dose of the rays and reported a histologic study of their eyes and gonads. They detected no changes in these tissues and concluded that the abnormalities which had developed in the descendants of the first group must have been caused by a direct hit on the germ plasm.

Lipschutz (1924), in his discussion of the internal secretions of the sex glands, gives the reasons for differences in reaction following roentgen exposure as:

1. Mode of irradiation
2. Species
3. Age
4. Condition

He states that interstitial tissue, if persisting, has to be provided from time to time with new cells from the follicles undergoing atresia. Four results are possible:

1. Degeneration of ova, follicles and interstitial tissue with ultimate replacement by common connective tissue.

2. Degeneration of ova and follicles, while interstitial tissue is injured only slightly or not at all. (Degeneration of follicles will cause reduction and disappearance of the interstitial tissue after a time.)

3. Injury of the follicles without full degeneration of ova, but increased atresia. Increase in interstitial tissue provided by obliterating follicles.

4. Transitions between these cases.

Parkes (1926), in the first of a series of papers dealing with the occurrence of the estrous cycle after roentgen sterilization, discusses the histologic effects of irradiation on mouse ovaries. The mice in these experiments were three weeks old at the time of irradiation. Constants for the dosage which gave the desired sterility were: 50 kv., 5 ma., wave length 0.285Å, spark gap 6.3 cm., 18 inches target distance, no filter. Eighty minutes of such irradiation, given in two exposures, was regularly found sufficient to sterilize female mice. This dosage was approximately $\frac{1}{4}$ B tint with Levi's pastilles. Histologic examination of the ovaries ten weeks after the exposure showed them to consist of "a mass of tissue of a parenchymatous nature, interspersed with cavities which possibly represent the original location of the follicles. These cavities usually contain varying amounts of eosinopholous matter, which appears to be entirely necrotic." By dissecting animals at weekly intervals for six weeks following the irradiation, the order of effects produced was observed to be a degeneration of all small oocytes, followed by maturation and segmentation changes in the older follicles. Rapid hypertrophy was not found among follicle cells and theca interna elements. The entire follicle inside the theca interna then degenerated and a new growth of tissue, which apparently came from the periphery, penetrated between the degenerating follicles, until within a few weeks after irradiation this tissue formed the entire ovary, the cells of the tissue forming fat-loaded cords surrounded by slight fibrous sheaths. A second proliferation of cords was found to originate from the germinal epithelium. In practically all of the irradiated ovaries examined, a variable number of cords in various stages of development was observed. The presence of atretic follicles or spurious corpora lutea did not seem to inhibit the appearance of these cords.

In a later communication Brambell, Parkes and Fielding (1927) discuss in detail the results of the experimentation which was earlier outlined in the preliminary paper by Parkes. The ovaries of 47 female mice which were three weeks old when exposed to a sterility dose of roent-

gen rays, are described. Camera lucida figures are given which show six stages in the degenerative process of the follicles in irradiated ovaries. These investigators state that a similar process of degeneration can be observed in any adult mouse ovary. The figures show the early disappearance of the oocyte and the crenating of the zona pellucida. During the degeneration of the oocyte the membrana granulosa has also undergone degeneration, the theca interna cells becoming detached and merging into the mass of follicular cell remnants. A little later (Fig. 4) "the follicle is represented by a few very pycnotic nuclei and cytoplasmic remnants, surrounding the old zona pellucida, in a cavity enclosed by the fibrous theca."

Referring to two particular ovaries (M39 and 1a) they find fibrous cells in some of the old follicles which seem to have penetrated the membrana granulosa and to have formed the wall of a cavity within it. "Outside the wall the membrana granulosa cells appear to persist, and to be changing and coming to resemble those that are being proliferated from the epithelium in the form of cords. They appear to be growing and forming a small zone around the old cavity, which stains slightly more deeply than the surrounding old stromal tissue." These cells are believed to become atrophic with other derivatives of the original stroma and to be pushed into the medullary zone by the growth of epithelial cords. The authors believe, since the normal follicular structure has disappeared, that these cells lack typical physiological function and they see no reason for considering them as follicle cells.

Old follicles show a difference in type of degeneration, the membrana granulosa and theca interna growing into the antrum and forming a "luteal-like structure." The zona pellucida remnant is often enclosed by this ingrowth.

Changes in the interfollicular tissue exhibit a growth of cords which are thought to be due to the "continued proliferation of the germinal epithelium and in part to the mitoses of their cells . . . . . Some connective tissue cells, apparently from the sheaths of the cords which originated from the tunica albuginea, seem to grow in between the cells of epithelial origin."

They find the estrous cycle continuing without a break in absence of corpora lutea and after the destruction of the follicles, and they think that the first proliferating cords may be the regulating factor. The second proliferating cords are thought to be independent of the estrous cycle. Structurally they resemble male seminiferous tubules and the authors hypothecate a possible reversal of sex by means of a physical agent, the roentgen ray.

The most recent workers have emphasized the importance of employing great care in the technique of exposure and the use of a standard dosage unit. Schugt (1928), working on the ovarian tissue of mice, has determined the sterilization dose for female white mice as 54 R. His investigation gives the histologic observations after six weeks, four and one-half months, and seven months, following exposures of 280, 140, 70, 54, 42, 21, 14, and 9 R. The ovaries of 108 animals were examined. Dosage groups for both hard and soft rays were represented by an average of six animals each. No difference in effect was noticed between the hard and soft rays.

Six weeks after the irradiation, ovaries exposed to 280 R showed the destruction of follicles with a coagulation of the oocytes or remnants of zona pellucida. There were many rows of shrunken membrana granulosa cells in the old follicles. The stroma was arranged in bars or in small patches. After a period of four and one-half months there was complete destruction of the follicles except for a few remnants of primary follicle rings. Quite similar structures were observed after exposure to 140 R. After seven months ovaries subjected to this dosage showed follicular epithelial remnants of one or more layers in both the periphery and interior of the glands. The stroma contained some large epithelial-

like cells and countless luteal cells arranged evenly or in clumps.

Six weeks after exposure to 54 R only coagulated remnants of oocytes were found, with an absence of intact eggs in primary follicles. Remnants of corpora lutea persisted. The stroma was arranged in bars and alveolar formation, with an extended luteal cell complex. After seven months, in ovaries exposed to this irradiation, the follicular remnants consisted of much spread out, one-layered follicles. The alveolar pictures were very clear in one particular animal.

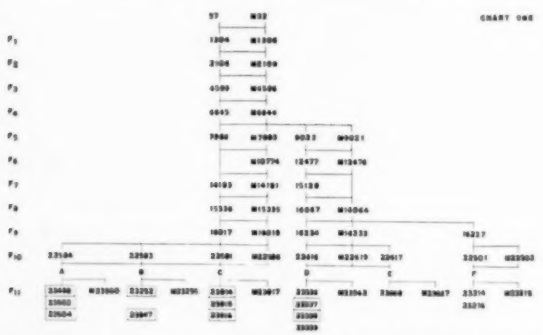
Six weeks after an exposure to 27 R, numerous atretic follicles were observed, also degenerative and ripe follicles. No primary follicles were present. Corpora lutea remnants remained, while the stroma showed a bar-like arrangement with few luteal cells. After four and one-half months ripe follicles were found and there were numerous primary follicles without oocytes. Corpora lutea in one animal filled almost the entire ovary.

The ovaries after 21, 14, and 9 R were found to contain normal structures four and one-half months after irradiation.

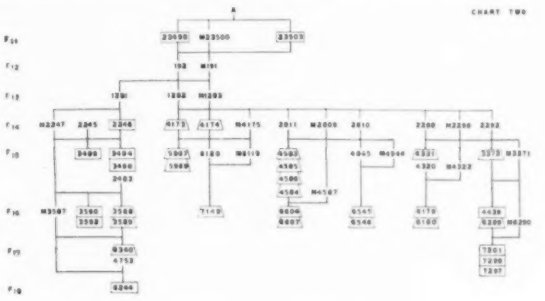
Schugt has followed the progeny of those animals which were not sterilized through three generations and has reserved the results for later publications.

## MATERIAL

The animals used in these experiments were taken from a closely inbred strain of brown mice (*Mus musculus*). A nucleus for the stock was obtained from Dr. C. C. Little in the fall of 1925. Pedigrees of these initial stock mice show them to be from the eleventh filial generation* and directly descended, by brother to sister matings with some back-crosses, from female No. 57 and male No. 52, two control animals (C 57-Brown) from one of Dr. Little's previous experiments. The pedigrees of these stock animals are shown in Chart I.

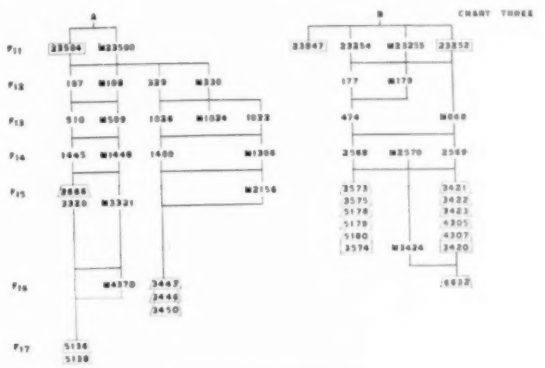


PEDIGREE CHART I. Pedigree of stock mice which traces back to the original pair of animals. The letters, A–F, between the tenth and eleventh filial generations represent lines of descent which are shown in Charts II to X.



PEDIGREE CHART II

The pedigree Charts II to X give the serial numbers and show the close relationship between the animals which were used for irradiation and those used for controls. They were progeny from the $F_{11}$ generation, as given in Chart I. The different lines of descent are represented by letters; the letter for each chart appearing at the beginning, at which point it can be

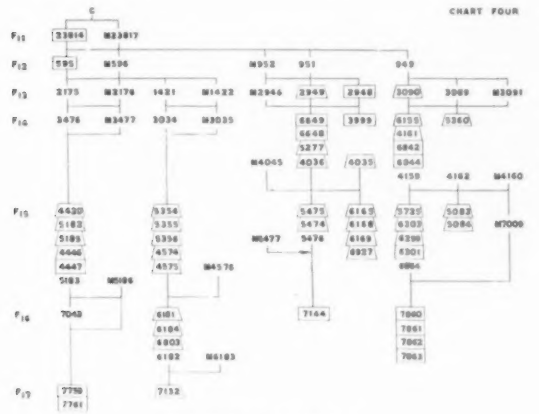


PEDIGREE CHART III

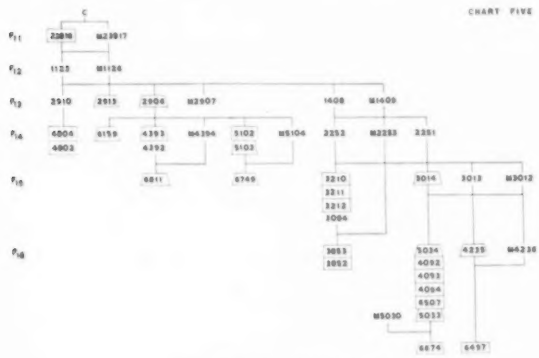
* The numerical filial generation designates the progressive mating away from the original pair of animals. The serial numbers of the stock mice whose ovaries were sectioned for controls are inclosed in rectangles on the charts.

joined to Chart I and followed back to the one pair of animals.

Each animal that has entered into the breeding record of the experiment is represented by its serial number. The numbers of the males are preceded by the letter "M". Serial numbers of the females from which ovaries were sectioned as control tissues are inclosed in rectangles, while the serial numbers of the irradiated animals are inclosed in trapezoids. Filial generations are designated numerically at the extreme left of each chart. The numerical value of the filial generation gives the progressive mating, in series, away from the original two animals. Sister to brother matings were used in most cases, with occasional back-crosses. Cousin matings were made (♂ 859, Chart VI; ♂ 780, Chart X) when the lack of males or females in the litters of breeding lines made this necessary.

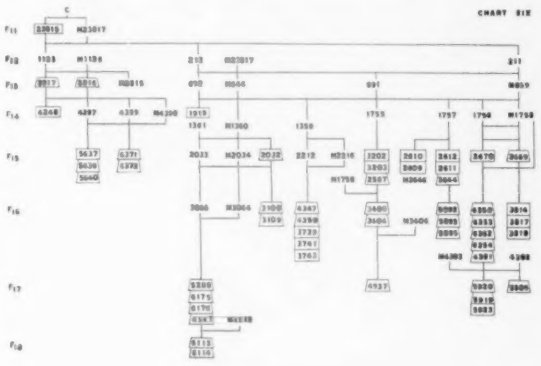


PEDIGREE CHART IV



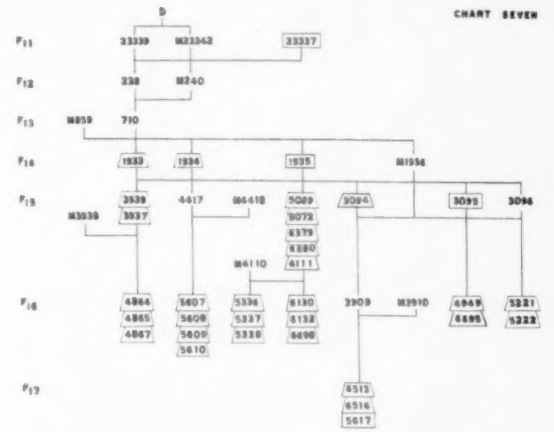
PEDIGREE CHART V

Progeny of the stock obtained from Dr. Little have been inbred since 1925. These mice form a vigorous and prolific strain and reach an average adult weight of 25 grams. Their coat color is chocolate* brown with a variable amount of white on the ventral surface of the trunk and on the tail. They are extremely tame and easily handled.



PEDIGREE CHART VI

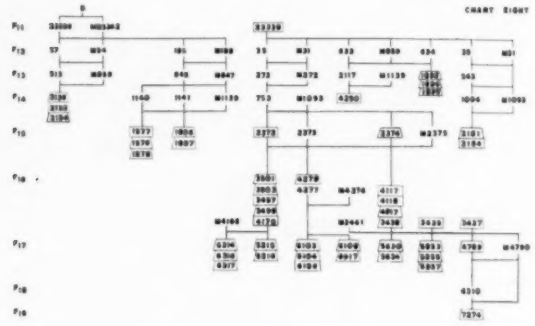
All the animals have been kept in clean, well-ventilated quarters, and have received similar food and care in order that their physical conditions might be the same, in so far as this is controllable. Breeding pens 15×12×12 inches were used for families of more than six animals. When observed to be pregnant, the animals were



PEDIGREE CHART VII. The pedigree of ♂859 is shown in Chart VI.

* Genetic constitution as expressed by factorial symbols of the American Mouse Club: *aa*, *bb* – – – –.

removed to separate pens, 12×6×6 inches, where they were left to parture and to raise their young to weaning age, usually three weeks. Records have been kept of the



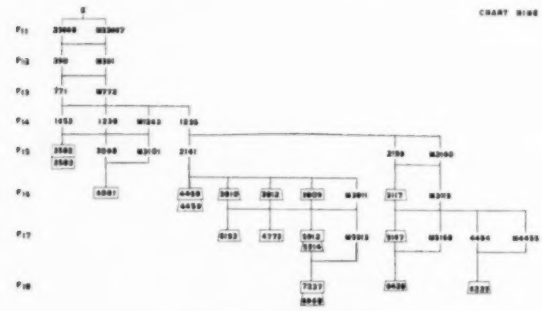
PEDIGREE CHART VIII

individual matings, time of birth, number of young born, and a description of the young at time of weaning.

Individual animals have been chosen from this stock for control and for experimental purposes. The collection of control ovarian tissues for histological investigation consists of tissues from 100 of these mice, and includes the ovaries of 10 of the original stock animals. One hundred and ninety-five animals were exposed to roentgen irradiation and their ovaries studied histologically.

## HISTOLOGY OF CONTROL OVARIES

The ovarian tissues which form the basis for the following observations were obtained from 100 stock animals, the description and pedigrees of which have just been given. Control mice were chosen at random, siblings of the irradiated animals

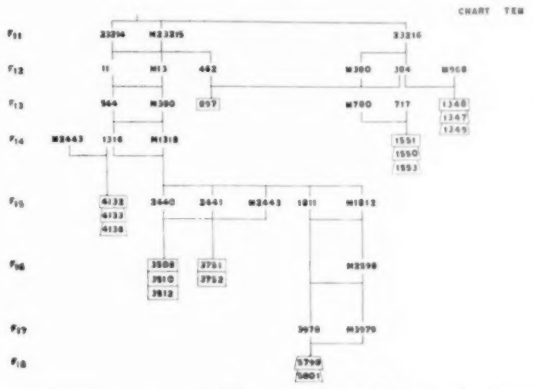


PEDIGREE CHART IX

being taken when possible. The collection of ovaries includes ten of the initial stock animals from the eleventh generation and the remainder from succeeding generations up to and including the eighteenth.

The pedigree charts give the serial number of the control animals inclosed in rectangles and show their close relationship to the numbers inclosed in trapezoids, which represent irradiated animals.

Ages of the mice at the time when ovaries were removed range between 49 and 537 days. As is shown in Tables I and II, 39 animals were killed between 49 and 100 days of age, 18 between 100 and 200 days, 15 between 200 and 300 days, 14



PEDIGREE CHART X. The pedigree of ♂780 is given in Chart III: $F_{12}$, progeny of ♀327 and ♂330. Male 2443, $F_{14}$, is the son of ♀1316 and ♂1318 and was back-crossed to his mother to give females 4132, etc.

between 300 and 400 days, and 14 between 400 and 537 days. These tables also give the letter designating the pedigree line, serial number, date of birth, date of death and age in days, arranged in series for each of the animals represented.

Preparation of the tissues follows the same procedure as is given in a later section for irradiated ovaries, except that eosin was used in place of Congo-red in ten of these series.

In order to avoid confusion in the consideration of control tissues, only those factors are included in these descriptions which have a direct bearing on subsequent comparison with the irradiated glands. The

TABLE I

CONTROL TISSUE

| Pedigree | Serial Number | Date of Birth | Date when Killed | Age in Days |
|---|---|---|---|---|
| C | 4248 | 11/19/27 | 1/ 7/28 | 49 |
| D | 4250 | " | " | 49 |
| F | 3751 | 9/22/27 | 11/11/27 | 50 |
| F | 3752 | " | " | 50 |
| C | 3739 | 9/21/27 | " | 51 |
| C | 3741 | " | " | 51 |
| C | 3743 | " | " | 51 |
| C | 4802 | 1/ 2/28 | 2/23/28 | 52 |
| C | 4804 | " | " | 52 |
| E | 4773 | 12/31/27 | 2/23/28 | 54 |
| F | 3508 | 9/ 4/27 | 11/ 4/27 | 61 |
| F | 3510 | " | " | 61 |
| F | 3512-R | " | " | 61 |
| C | 3852 | 10/ 3/27 | 12/ 3/27 | 61 |
| C | 3853 | " | " | 61 |
| C | 3814 | 9/30/27 | " | 64 |
| C | 3817 | " | " | 64 |
| C | 3818 | " | " | 64 |
| D | 4117 | 11/ 2/27 | 1/ 7/28 | 66 |
| D | 4118 | " | " | 66 |
| C | 4092 | 11/ 1/27 | " | 67 |
| C | 4093 | " | " | 67 |
| C | 4094 | " | " | 67 |
| E | 4081 | 10/31/27 | " | 68 |
| A | 3490 | 9/ 2/27 | 11/11/27 | 70 |
| A | 3494 | " | " | 70 |
| F | 3512-L | 9/ 4/27 | 11/14/27 | 71 |
| C | 3210 | 8/18/27 | 11/ 4/27 | 78 |
| C | 3211 | " | " | 78 |
| C | 3212 | " | " | 78 |
| C | 3999 | 10/19/27 | 1/ 7/28 | 80 |
| A | 4439 | 12/ 3/27 | 2/23/28 | 82 |
| A | 3590 | 9/11/27 | 12/ 3/27 | 83 |
| A | 3592 | " | " | 83 |
| E | 3582 | 9/10/27 | " | 84 |
| E | 3583 | " | " | 84 |
| C | 3202 | 8/17/27 | 11/11/27 | 86 |
| C | 3203 | " | " | 86 |
| A | 3486 | 8/31/27 | 12/ 3/27 | 94 |
| C | 7860 | 10/13/28 | 1/23/29 | 101 |
| C | 7861 | " | " | 101 |
| C | 7862 | " | " | 101 |
| C | 7863 | " | " | 101 |
| C | 7759 | 10/ 5/28 | 1/23/29 | 109 |
| C | 7761 | " | " | 109 |
| C | 2609 | 6/13/27 | 11/11/27 | 151 |
| C | 2610 | " | " | 151 |
| C | 2611 | " | " | 151 |
| C | 2612-L | " | " | 151 |
| A | 7301 | 8/11/28 | 1/23/29 | 164 |

TABLE II

CONTROL TISSUE

| Pedigree | Serial Number | Date of Birth | Date when Killed | Age in Days |
|---|---|---|---|---|
| A | 7299 | 8/11/28 | 1/23/29 | 164 |
| A | 7297 | " | " | 164 |
| E | 7237 | 8/ 1/28 | " | 174 |
| A | 6244 | 3/30/28 | 9/26/28 | 180 |
| C | 6301 | 4/ 3/28 | 10/10/28 | 190 |
| A | 2246 | 5/ 4/27 | 11/11/27 | 191 |
| E | 5912 | 3/13/28 | 9/26/28 | 197 |
| D | 6106 | 3/20/28 | 10/10/28 | 204 |
| C | 7144 | 6/27/28 | 1/23/29 | 209 |
| D | 5617 | 2/23/28 | 9/26/28 | 216 |
| C | 5923 | 3/13/28 | 10/25/28 | 226 |
| C | 5637 | 2/24/28 | 10/10/28 | 229 |
| C | 6844 | 5/31/28 | 1/23/29 | 236 |
| C | 6842 | " | " | 236 |
| D | 4170 | 11/ 6/27 | 7/ 2/28 | 239 |
| C | 2612-R | 6/13/27 | 2/14/28 | 246 |
| C | 6649 | 5/ 2/28 | 1/23/29 | 265 |
| C | 6648 | " | " | 265 |
| C | 5102 | 1/26/28 | 10/25/28 | 273 |
| C | 6507 | 4/17/28 | 1/23/29 | 280 |
| C | 6497 | " | " | 280 |
| E | 3809 | 9/30/27 | 7/25/28 | 299 |
| C | 4447 | 12/ 7/27 | 10/10/28 | 308 |
| B | 3574 | 9/10/27 | 7/23/28 | 317 |
| D | 3497 | 9/ 3/27 | 7/23/28 | 324 |
| D | 3439 | 8/30/27 | 7/23/28 | 328 |
| B | 3420 | 8/29/27 | 7/27/28 | 333 |
| F | 4132 | 11/ 3/27 | 10/10/28 | 342 |
| D | 1577 | 2/15/27 | 1/27/28 | 346 |
| F | 1551 | 2/ 6/27 | " | 355 |
| F | 897 | 9/ 9/26 | 9/ 6/27 | 362 |
| C | 2948 | 7/24/27 | 7/25/28 | 367 |
| C | 23814 | 11/26/25 | 12/11/26 | 380 |
| C | 23815 | " | " | 380 |
| C | 23816 | " | " | 380 |
| F | 1348 | 1/ 4/27 | 1/27/28 | 388 |
| A | 23498 | 11/ 6/25 | 12/11/26 | 400 |
| A | 23503 | " | " | 400 |
| A | 23504 | " | " | 400 |
| D | 23338 | 10/24/25 | 12/11/26 | 413 |
| D | 23337 | " | " | 413 |
| D | 3095 | 8/ 3/27 | 9/26/28 | 420 |
| B | 23252 | 10/12/25 | 12/11/26 | 425 |
| C | 1919 | 4/ 4/27 | 6/ 5/28 | 428 |
| D | 2372 | 5/16/27 | 7/23/28 | 434 |
| C | 595 | 6/21/26 | 9/ 7/27 | 443 |
| D | 2184 | 4/26/27 | 7/23/28 | 454 |
| C | 2670 | 6/23/27 | 9/26/28 | 461 |
| B | 23847 | 11/27/25 | 5/ 5/27 | 524 |
| D | 1935 | 4/ 8/27 | 9/26/28 | 537 |

cystic structures will only be mentioned in the general description and will be considered as a group at the end of the section.

By combining the animals into age groups for descriptive purpose, an attempt has been made to follow a grouping which is comparable with the normal functional intervals of reproductive activity: *i.e.*, 49–100 days, the beginning of active breeding; 100–200 days and 200–300 days, the early and late periods of greatest reproductive activity; 300–400 days and 400–537 days, the early and late periods of reduced reproductive activity.

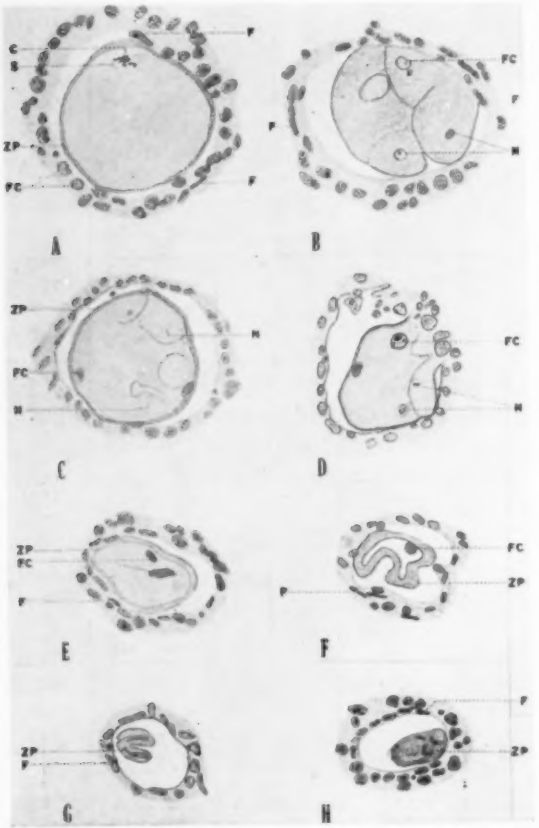



Fig. 1. Stages in the degeneration of ovarian follicles in stock animals. Camera lucida drawings. A. Ovary 3814, 64 days of age, showing an early degenerative stage of the oocyte. The oocyte has begun to shrink away from the follicle cells, zona pellucida is thickened and the chromosomes have formed on a spindle. This chromosome picture extends into the next section and indicates the first maturation spindle. The follicular cells have lost their regular arrangement, are spread out and irregular in shape, with no active mitoses. B. Ovary 7761, 109 days of age, showing fragmentation and shrinking of the oocyte, with greater thinning out of the follicular cell elements and presence of fibrous cells migrating in toward the antrum which has been formed by shrinkage and degeneration. C. Ovary 7144, 209 days of age, showing further shrinkage and fragmentation of the oocyte, with migration of follicular cells and their inclusion within the thickened zona pellucida. D. Ovary 2670, 461 days of age, showing a more marked shrinkage of the oocyte, fragmentation of oocyte and follicular cell inclusions. E. Ovary 3814, 64 days of age, showing marked shrinkage and degeneration of the oocyte, thickened zona pellucida and follicular cell inclusions. F. Ovary 7144, 209 days of age, showing the total degeneration of the oocyte with the persisting follicular cell inclusion and beginning of the zona pellucida folding. G. Ovary 7144, 209 days of age, showing an end view of the ultimate twisting and clumping of the zona pellucida remnant. H. Ovary 4773, 54 days of age, showing another view of the zona pellucida remnant and the fibrous-cell sheath which surrounds the antrum which has been formed by degeneration and shrinkage of the follicle. Guide letters: C—chromosomes; F.C.—follicular cells; F—fibrous tissue cells; N—nuclei; S—spindle; Z. P.—zona pellucida.

*Ages 49 to 100 Days:* Thirty-nine animals were killed between the ages of 49 and 100 days.

Ten of these animals were killed between the ages of 49 and 54 days. The ovary of female 4248, 49 days of age, shows growing follicles in all stages of development. No corpora lutea are present. The germinal epithelium is not invaginated and covers the gland except at the hilum. Oocytes, with or without primary follicular epithelial investments, are numerous in the fibrous tunica albuginea. They are not found in nests or cords. Degenerating follicles with fragmenting oocytes are found scattered among the normal follicles. The predominating structures in the medullary region, other than the common stromal elements, are the numerous eosinophilic clear masses which lie in small, fibrous bordered cavities. These masses, or hyaline clumps, constitute the remnants of the zona pellucida of the oocytes and represent a stage in follicular degeneration. Figure 1 shows camera lucida drawings of this degeneration process which is common to mouse ovaries at all ages studied.

The ovary of female 4250, 49 days, shows essentially the same structures as are seen in

4248, with the exception of the presence of corpora lutea. These bodies cause a considerable enlargement of the gland. Figure 2 is a section from this ovary and shows the prolific

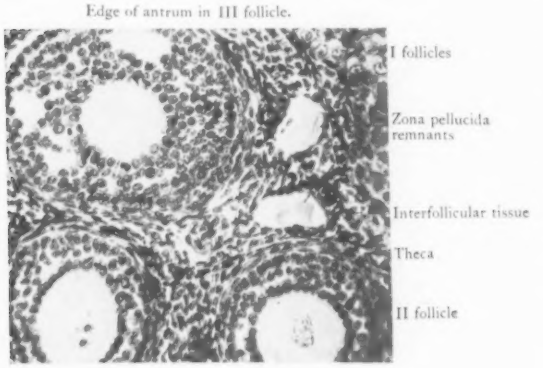



Fig. 2. A section of ovary 4250, 49 days of age, which shows in a peripheral field the presence of normal follicles in different stages of development. Mitotic activity is shown by the chromatin figures in the follicular cells, while zona pellucida remnants represent late stages of follicular degeneration (×360).

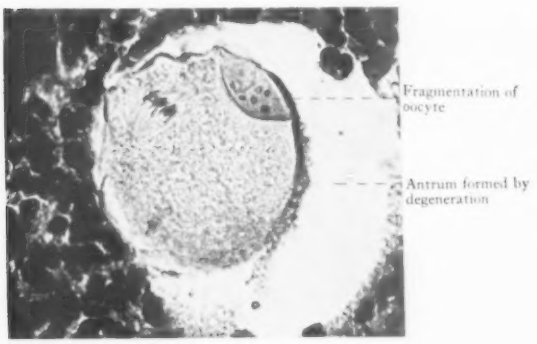
growth of primary and secondary follicles. Late follicular degeneration stages are represented by the hyaline clump remants of the zona pellucida.

The ovaries of 8 animals represent stages from 50 to 54 days of age. The hyaline clumps are numerous except in the 52 and 54 day old individuals, where they are relatively scarce. Active development of normal follicles is prominent, while degenerating follicles and fragmenting ova are common. Two of the 51 day old ovaries have small epithelium-lined cysts in the hilum of the glands. A further description of these structures will be given at the end of this section. The presence of the corpora lutea is not regular in animals of this age. In the two 50 day old, and one of the 52 day old animals, these bodies are present, while they are absent in two 51 day old, one 52 day old and 54 day old animals.

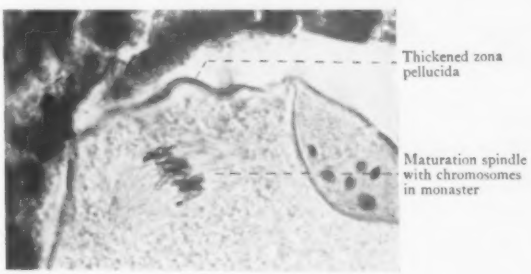
Fourteen of the animals were killed between 61 and 70 days of age. Normal follicles in all stages of development are found in each of the ovaries. All but three of the animals, female 3510, 61 days old; female 3853, 61 days old; and female 3818, 64 days old, show corpora lutea in various stages. Degenerating follicles are frequently met with, but the number of hyaline clumps varies widely. Epithelium-lined cysts are present in six of the ovaries but in all cases are small and situated near the hilum.

Ovaries from the six animals which were killed between 70 and 80 days of age are found to have normal follicles in all stages of development. Degenerating follicles and fragmenting ova are prevalent and the hyaline clumps are very numerous. Two animals of 70 days and the one 71 days old show no evidence of corpora lutea. A small epithelial ingrowth in the medulla of female 3211, 78 days old, appears to be an encysted portion of oviduct.

Ovaries from the nine animals killed between 80 and 94 days of age have normal follicles in all stages of development. Female 3590, 83 days old, was the only one which lacked corpora lutea. This individual also showed a small epithelial cyst in the hilum. Many degenerating follicles and numerous hyaline clumps are present. An early stage of follicular




A




B

Fig. 3. Ovary 3583, 84 days of age. An early stage in the degeneration of a II follicle, which shows the oocyte with first maturation spindle and chromosomes in monaster, zona pellucida thickening and a beginning of fragmentation. The membrana granulosa cells have lost their characteristic arrangement and are becoming loosened and are pulling away from the oocyte (A, ×600; B, ×820).

degeneration is shown in Figure 3, A and B, taken from female 3583, 84 days of age.

*Ages 100 to 200 Days.* Eighteen animals were killed between the ages of 100 and 200 days.

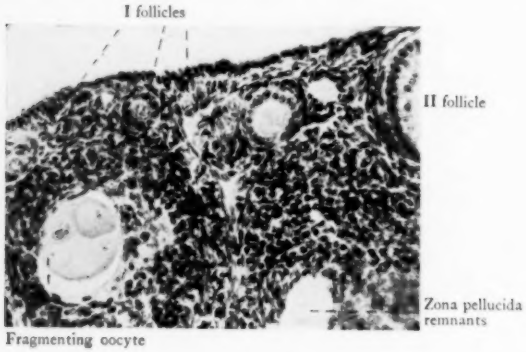



FIG. 4. A peripheral section from ovary 7761, 109 days of age, which shows the characteristic follicular activity in ovaries of this age. The degeneration of follicles by fragmentation of an oocyte is shown, and an antrum containing a zona pellucida remnant (×360).

Ovaries 7860, 7861, 7862 and 7863, 101 days of age, have many normal follicles in all stages of development, corpora lutea, degenerating follicles and numerous zona pellucida remnants. The medulla is rich in large blood vessels with smaller vessels extending between the follicular elements of the cortex. There is no evidence of germinal epithelial ingrowths or anovular rings. The primary follicles are plentiful and lie near the periphery and are separated by fibrous tissue of stroma beneath the tunica albuginea. Ovary 7863 has a very small epithelium-lined cyst at the hilum.

Two animals, 7759 and 7761, were killed at 109 days of age. The ovaries of these two animals are full of normal follicles in all stages of development, corpora lutea, degenerating follicles and zona pellucida remnants. Early degenerating stages with fragmenting ova are common. The great quantity of follicular elements has crowded the stromal tissue into thin bands which are pushed in between the thecal layers of the follicles. Germinal epithelial invaginations are not evident, except between the corpora lutea which bulge out from the periphery. Anovular rings are absent. Figure 4 shows the structure of a peripheral section from female 7761.

Four animals, 2609, 2610, 2611 and 2612-L, were killed at the age of 151 days. The ovaries from these animals are active in production of normal follicles of all stages. The primary type of follicle is numerous. Corpora lutea are present in all these glands; degenerating follicles with fragmenting ova are common. The zona pellucida remnants are very numerous, showing 20 or more in each of the sections cut near the middle of the gland. The germinal epithelium does not invaginate and anovular rings or cell nests are not present. Female 2610 from this group has an epithelium-lined cyst at the hilum.

The ovaries of three animals, 7297, 7299 and 7301, 164 days of age, show many normal follicles at all stages of development, degenerating follicles with fragmenting ova and zona pellucida clumpings. Corpora lutea are present, freshly ovulated and very hemorrhagic. The germinal epithelium does not invaginate and anovular rings are absent. A hemorrhagic cyst with cuboidal epithelium lining is present at the hilum of 7301.

The ovary of female 7237, 174 days of age, is rich in normally developing follicles at all stages. There are many degenerating follicles around the periphery, with zona pellucida remnants throughout the gland. The germinal epithelium shows small areas of invagination with a few anovular rings. The corpora lutea are quite freshly ovulated with persisting areas of hemorrhage at the centers. In the hilum a large cyst is present. The lining is of a cuboidal epithelium which is in part papillated, with elongated columnar cells in these papillated regions.

The ovary of female 6244, 180 days of age, shows many normal follicles in all stages of development. There are many degenerating follicles and fragmenting ova, with zona pellucida remnants numerous in both the medullary and cortical zones. The germinal epithelium is smooth and does not invaginate to form anovular rings in the cortex.

The ovary of female 6301, 190 days of age, has normal follicles in all stages of development. Early stages of follicular degeneration are scarce, while zona pellucida remnants are very numerous. The germinal epithelium does not show invaginations. A cyst fills up a portion of the hilum.

The ovary of female 2246, 191 days of age, is very active and shows numerous follicles at all stages of development. Large vacuolated areas indicate degeneration of ripe follicles.

Many degenerating follicles and fragmenting ova are present, while zona pellucida remnants are spread throughout the medulla. No corpora lutea are present.

The ovary of female 5912, 197 days of age, was cut in broken series. It shows normal follicles in all stages of development, degenerating follicles and fragmenting ova. Zona pellucida remnants are relatively few but many clear spaces represent this ultimate stage in the follicular degeneration. The hilum contains an epithelium-lined cyst. Anovular rings invaginating germinal epithelium and corpora lutea are not present.

*Ages 200 to 300 Days.* Fourteen animals were killed between the ages of 200 and 300 days.

The ovary of female 6106, 204 days of age, has many primary follicles and others in more advanced stages of development. There are many degenerating follicles and zona pellucida remnants, with a number of old corpora lutea. The germinal epithelium shows some slight invagination with a few follicular rings near the periphery. The general arrangement of the structural elements is not markedly different from those of the last group except that the follicles are separated by more stromal tissue.

The ovary from female 7144, 209 days old, is rich in normal follicles in all stages of development. There are a number of fresh corpora lutea showing hemorrhagic areas in the centers, while degenerating follicles, fragmenting ova and zona pellucida remnants are numerous. Figure 5 is a photomicrograph showing a portion of the periphery.

Female 5617 was killed at 216 days of age. The ovary has many normal follicles in all stages of development, degenerating follicles and very numerous zona pellucida remnants. Corpora lutea are present. The germinal epithelium shows no invaginations and the periphery is free of anovular rings.

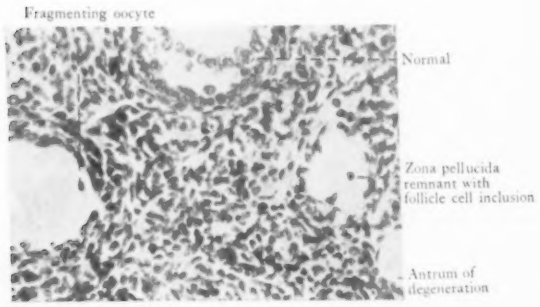



Fig. 5. A section from the periphery of ovary 7144, 209 days of age, showing degenerating follicles in relation to one which is developing normally (×470).

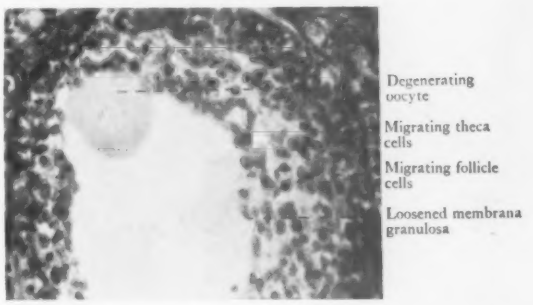



Fig. 6. A section from the periphery of ovary 5637, 229 days of age, showing the type of degeneration characteristic for follicles which have reached a late stage of development. The oocyte, with chromosomes showing indistinctly, is vacuolated and breaking up. The follicle and theca cells are seen, spreading out and in loosened arrangement, migrating into the antrum which they ultimately fill (×470).

Female 5923 was killed at 226 days of age. The ovary shows normal follicular structures in active development. Degenerating follicles and zona pellucida remnants are numerous. The germinal epithelium shows no invaginations. Corpora lutea are present and an epithelium-lined cyst fills up the hilum of the gland.

The ovary of female 5637, 229 days of age, shows essentially the same structures as 5923, except for the absence of any cyst. Figure 6 is a high power photomicrograph of a section of the periphery of this gland.

Females 6842 and 6844 were killed at 236 days of age. Ovaries from these mice are rich in normal follicles of all developmental stages. Degenerating follicles and zona pellucida remnants are also numerous. Ovary 6842 shows no corpora lutea, the gland having an especially thick fibrous tunic. A portion of the oviduct which has become encysted in the hilum is filled with large, vacuolated, luteal-like cells.

Ovary 6844 also shows a cyst. The type of lining is different from that in 6842, with evidence of continuity between the germinal epithelium and cyst epithelium.

The ovary of female 4170, 239 days of age, contains many normal follicles in early stages

of development, but relatively few follicles in advanced stages. Many degenerating follicles are present and a large part of the gland is made up of corpora lutea. A large cyst with

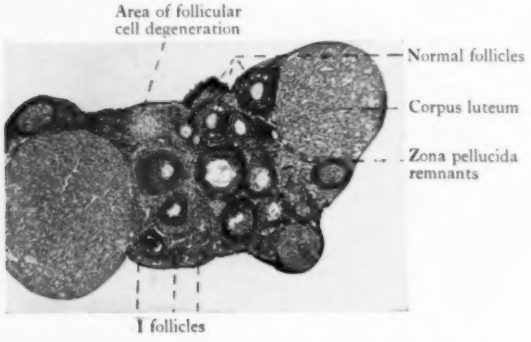



Fig. 7. A whole section from ovary 6497, 280 days of age, which shows the normal follicular elements at this age, with corpora lutea and degeneration remnants of both the zona pellucida and follicular cell type (×54).

actively proliferating epithelial lining is found in the hilum. Germinal epithelial invaginations are not present except between the bulging corpora lutea.

The ovary of female 2612, 246 days of age, is greatly enlarged by many corpora lutea. There are many normal follicles in all stages of development, degenerating follicles, and hyaline clumps.

The ovary of female 6649, 265 days of age, is essentially similar to that of 2612; a functionally active gland showing both normally developing follicles and marked follicular degeneration.

The ovary of female 6648, 266 days of age, does not have as many corpora lutea, but is otherwise similar to 6649. The picture of functional activity at this age is very markedly increased.

The ovary of female 5102, 273 days of age, has normal follicles in all stages of development. Degenerating follicles and hyaline clumps are numerous. There is an absence of corpora lutea. Large blood vessels are seen throughout the gland. The hilum contains a cyst, lined with cuboidal epithelium and containing a mucus plug.

The ovaries of females 6497 and 6507, 280 days of age, are quite similar. Figure 7, female 6497, shows a typical picture of these glands. The normal follicles are numerous and of all developmental stages. Degenerating follicles and zona pellucida remnants are common in all sections. The corpora lutea are large and bulge from the periphery to greatly enlarge the gland.

The ovary of female 3809, 299 days of age, has normal follicles in all stages of development. Numerous corpora lutea almost completely fill parts of the gland. Degenerating follicles and zona pellucida remnants are present in each section. The germinal epithelium shows small areas of invagination and a few anovular epithelial rings are found out near the periphery.

*Ages 300 to 400 Days.* Fourteen animals were killed between the ages of 300 and 400 days.

The ovary of female 4447, 308 days of age, shows a reduction in the number of normally developing follicles. There are a great many degenerating follicles in older stages, the zona pellucida remnants being relatively scarce. Corpora lutea are not present, but a number of corpora albicantia fill in large areas of the cortical zone. The germinal epithelium shows a number of regions with short invaginations into the tunica albuginea. Anovular rings are found in these regions.

The ovary of female 3574, 317 days of age, shows many more normally developing follicles than were found in 4447. Degenerating follicles are few in number, the ova showing fragmentation in these few. Corpora lutea and albicantia are present and form a large portion of the gland. Germinal epithelium invaginations are seen only between the corpora lutea elevations. A few anovular rings are seen around the periphery.

The ovary of female 3497, 324 days of age, has many normal follicles in all stages of development. A few degenerating follicles and hyaline remnants are evident. The greater part of the organ is made up of an interstitial gland-like structure which is separated into small areas by fibrous tissue septa. A few anovular rings are found near the periphery. Germinal epithelium invaginations or corpora lutea are not evident.

The ovary of female 3439, 328 days of age, shows normal follicles in all stages of development. The degenerating follicles are mostly of the older follicle type and form a number of areas around the cortical zone. Zona pellucida remnants are scarce. Remnants of corpora lutea are present, but as in the last ovary, 3497, the greater part of the organ is made

up of interstitial gland-like areas. Small regions of germinal epithelium invaginations are seen, with a few anovular follicular cell nests spread through the peripheral tunic.

The ovary of female 3420, 333 days of age, has normal follicles in all stages of development. Degenerating follicles and zona pellucida remnants are present, with a number of vacuolated cell areas which are derived from the follicular degeneration. Corpora lutea are present. Germinal epithelium invaginations are seen in small areas but do not form anovular rings.

The ovary of female 4132, 342 days of age, is essentially like the latter, 3420, with the exception that it does not show a number of anovular rings in the peripheral zone.

The ovary of female 1577, 346 days of age, is very prolific in follicular development. Figure 8, a section of this gland, shows the normal follicles in all stages of development, degenerating follicles, hyaline clumps and corpora lutea. The gland contains a large cyst in the hilum, which is not shown in the section pictured. Primary follicles, although relatively few in number, are found in each section.

The ovary of female 1551, 355 days of age, shows essentially the same picture as 1577, with the exception that no cyst exists in the hilum.

The ovary of female 897, 362 days of age, shows a follicular and interfollicular picture quite similar to the latter but the germinal epithelium is markedly different. Invaginating areas are found in many parts of the glands, anovular rings showing the tunica albuginea.

The ovary of female 2948, 367 days of age, shows an active proliferation of normal follicles. The gland contains numerous large corpora lutea and albicantia and is, in general, more characteristic of the 200–300 day old group than of the age group in which it falls.

The ovaries of females 23814, 23815, 23816, 380 days of age, are three of the tissues from the original stock of the experiment. Normally developing follicles of all stages are present in these glands. Degenerating follicles are more numerous than the zona pellucida remnants. Corpora albicantia are structures commonly met with, while corpora lutea are not present. The germinal epithelium shows very little invagination and no anovular rings. Ovary 23816 has a cyst in the hilum.

The ovary of female 1348, 388 days of age, shows normal follicles in all stages of development. The remnants of degenerating follicles and corpora albicantia break the interfollicular tissues up into trabeculated areas; zona pellucida remnants are scarce, while corpora lutea are absent. A large cyst fills up the greater portion of the hilum. The germinal epithelium invaginations are not evident.

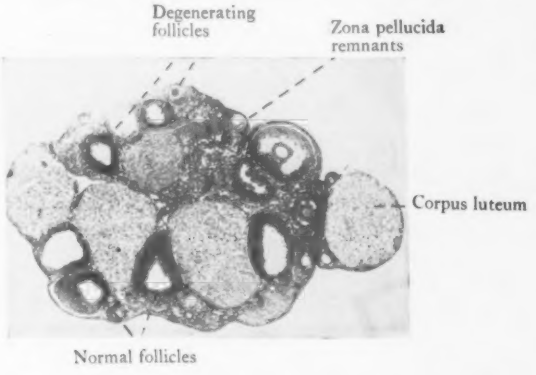



Fig. 8. A whole section from ovary 1577, 346 days of age, which shows the functional activity of this gland. Many normal follicles, degeneration remnants and corpora lutea are present, the interfollicular elements being compressed and making a relatively small portion of the organ (×54).

*Ages 400 to 537 Days.* Fourteen animals were killed between the ages of 400 and 537 days.

The ovaries from females 23498, 23503, and 23504, 400 days of age, show normal follicles in all stages of development. The interfollicular portions of the glands are more densely fibrous and help to separate the normal and degenerating follicular elements more widely. No corpora lutea are present but fragments of corpora albicantia are spread here and there throughout the gland. Ovary 23503 shows marked invagination of the germinal epithelium with some anovular rings situated near the periphery. The other two ovaries do not show this marked invagination of the germinal epithelium but they all have anovular follicular nests with some cord formation. The primary follicles are especially numerous and some of them are found deep in the cortical zone. Figure 9 is a low power photomicrograph of a section from this gland.

The ovaries of females 23337 and 23338, 413 days of age, have many normal follicles. No corpora lutea are present but corpora albicantia are found in both glands. Areas of fatty

degeneration are present. The degenerating follicles have formed into irregular areas with fibrous tissue septa between. There is practically no evidence of zona pellucida remnants. The germinal epithelium is deeply invaginated in ovary 23338 and anovular rings have been formed with follicular cell nests in close relation to them. Ovary 23337 shows a cyst in the hilum.

The ovary from female 3095, 420 days of age, contains a large cyst which forces the gland off to one side. Normal follicles of all

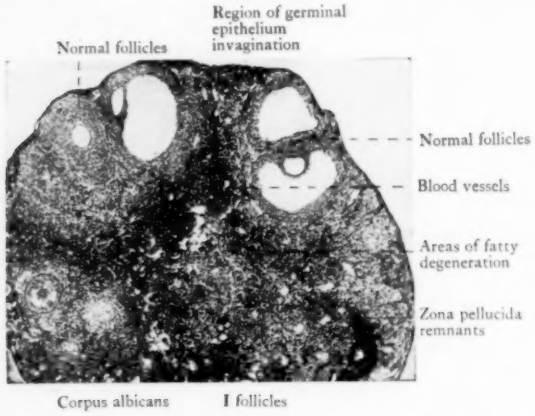



Fig. 9. A section from ovary 23503, 400 days of age, which shows the normal follicular elements at this age. Small areas of fatty degeneration are shown spread through the fibrous elements of the medulla (×88).

stages are present, with very few of primary type. There are many degenerating follicles with numerous zona pellucida remnants. Corpora lutea and albicantia are present, both bodies being relatively small. The germinal epithelium shows only short areas of invagination and but few anovular rings.

The ovary of female 23252, 425 days of age, presents a few normal follicles of secondary and tertiary type. The tunica albuginea is thickened and contains invaginations of the germinal epithelium with many anovular rings. Follicular and fatty degeneration areas make up a large portion of the gland. The stroma is fibrous and shows no evidence of zona pellucida remnants.

The ovary of female 1919, 428 days of age, has normal follicles of all types. Degenerating follicles are numerous, while the zona pellucida remnants are very scarce. The degenerating remnants of smaller follicles have taken on a vacuolated, cord-like shape or have formed irregular areas which are surrounded by fibrous tissue septa. Corpora lutea are not present, a number of fatty degeneration areas being the only remnants. The germinal epithelium shows only a few slight invaginations and anovular rings are not found. A large cyst fills up the hilum of the gland.

The ovary of female 2372, 434 days of age, has normal follicles of all types. Degenerating follicles and fatty degeneration areas are prevalent, with only scattered zona pellucida clumps. Fresh corpora lutea are present, as well as corpora albicantia of early degenerating stages. The tunica albuginea is thickened in part and contains numerous anovular rings and cell nests.

The ovary of female 595, 443 days of age, has many normal follicles of all types, corpora lutea and albicantia, degenerating follicles and zona pellucida remnants. The areas of fatty degeneration, thickened tunica albuginea and follicular rings are similar to other tissues at about this age. A small cyst is present in the hilum.

The ovary of female 2184, 454 days of age, contains normal follicles of all types. Areas of fatty degeneration, follicular degeneration and a few zona pellucida remnants are prominent among the stromal elements. Corpora lutea form bulges around the periphery. Between such elevations there is a thickening of the fibrous tunic which contains some anovular rings. The hilum contains a small cyst.

The ovary of female 2670, 461 days of age, has normal follicles of all stages. There are many degenerating follicles and zona pellucida remnants. Corpora lutea are not present. Fatty degeneration areas are small, but widely dispersed throughout the gland. The tunica albuginea is thick and shows the formation of anovular rings. A cyst is present in the hilum.

The ovary of female 23847, 524 days of age, forms a crescent-shaped mass around the periphery of a large cyst, the germinal epithelium being closely adherent to the fibrous capsule. Only 54 sections of this gland were saved, due to the size of the cyst, but they represent various depths of the tissue from one side to the other. Normal follicles of the older types are present, with very few of the primary type. Degenerating follicles and a few zona pellucida remnants are present. The interfollicular tissue is fibrous and arranged in irregular cord-like areas. No corpora lutea are present.

The ovary of female 1935, 537 days of age, contains numerous normal follicles of all types, many degenerating follicles and zona pellucida remnants. No corpora lutea are present. Corpora albicantia and small areas of fatty degeneration are spread throughout the gland. The tunica albuginea is thick, with only slight germinal epithelium invagination and few anovular rings.

In these 100 ovaries, which were taken from stock as controls, 33 were found to have epithelium-lined cysts. The distribution of this structure shows it to be common to all the age groups:

| | | | | | |
|---|---|---|---|---|---|
| 49–100 | days— | 39 | animals | —11 | cysts |
| 100–200 | " — | 18 | " | — 7 | " |
| 200–300 | " — | 14 | " | — 5 | " |
| 300–400 | " — | 14 | " | — 2 | " |
| 400–537 | " — | 15 | " | — 8 | " |

As has been mentioned in the individual general descriptions, these cysts vary greatly in size, ranging between the extreme where the ovarian tissue is pushed off to one side and compressed to a thin crescent-shaped mass by a cyst many times its size, and the opposite extreme of a small cavity the size of a normal follicular antrum.

No definite line of the stock animals shows a particular tendency toward the formation of cysts, so far as can be determined with so small a percentage of the total number of animals represented.

The type of epithelium which lines the cysts varies between a flattened, pavement-cell type and a tall columnar. Cilia are present on portions of the columnar epithelium and some papillation occurs in those cysts whose thin walls are seen to protrude into the muscle and connective tissue elements of the hila of the glands.

A tabulation of age of the individual, relative size of the cysts, type of epithelium and relation to the presence of corpora lutea shows no correlation between these factors.

No particular emphasis has been placed by other authors on the physiological importance of the presence of cystic structures in mouse ovaries. These present observations would seem to indicate that normal ovulations occur in all but a small percentage of cyst-containing glands.

### DISCUSSION OF CONTROL OVARIES

Investigations dealing with the tissue elements of living mammals are very often hampered by the wide range of variation which exists between the individual animals available for study. Many factors which directly influence the results of animal investigations are controllable within reasonable limits of error; i.e., species, sex, age and so forth, and these factors have been accepted as definite bases upon which the correlation of results is determined. The value of a biological investigation might be classified according to the emphasis given to the control of the material which is employed. This knowledge of the material is an initial factor, and unless great care is exercised in the selection of animals on which necessary detail is available, adequate control of the more technical factors is, in most cases, of little purpose and does not serve to offset the uncertainty introduced by the major factor.

In roentgen work the clinician encounters perhaps as heterogeneous a group of materials as can be found in one species. Since it is not possible to remedy or control this variation, all possible effort is directed toward the proper classification according to type. This "typing" would, of course, include the sex, age, physical condition, clinical or pathological diagnosis, etc., and the physical application of roentgen rays would change accordingly.

With experimental animals, on the other hand, it is possible to inbreed for many generations and bring the material to as near a state of homogeneity as is possible. The factor of individual variation in mammals cannot be eliminated by this inbreeding, but it has been found that such inbred individuals are much more like each other in their physiological reaction, and resemble each other much more closely than do heterogeneous animals of the same species.

As has already been stated, the control and experimental ovaries considered in these experiments were taken from a strain of mice which had been inbred for from 10 to 19 generations. An analysis of the ovaries from these animals was undertaken to ascertain what correlation existed between the structure of the various age groups of such an inbred strain, and to use the control ovaries for comparison and check with those which were irradiated.

The most characteristic structures found in these ovaries, other than the normally developing follicles, are the various stages of follicular degeneration. Since the study of irradiated ovaries is chiefly concerned with the degree of follicular degeneration produced, this normally existing degeneration is important and holds special interest.

Earlier investigators have reported degenerative processes to occur in mouse ovaries. Kingery (1914), in his observations on the follicular changes in the ovaries of white mice, found that in atretic follicles the oocytes often go through a process which resembles maturation, and reviews the work of Bonnet, Newman, Van der Stricht, Rubaschkin and Athias, who interpret their evidence to indicate that this process is a maturation with parthenogenetic cleavage up to the three-cell stage—a beginning of true parthenogenesis—then degeneration and fragmentation.

Kingery found the most marked degeneration among animals between 25 and 40 days old. The degeneration of the follicle appeared to stimulate the oocyte to pass through a more or less abnormal maturation. The cytoplasm was observed to break up and surround several of the nuclear clumps or to remain without any nucleus, and in this way a morula was frequently formed. The zona pellucida usually persisted as a thick, transparent membrane after the oocyte had disappeared, and follicular cells from the degenerating follicle sometimes came to line the inner surface of this zona pellucida remnant. These follicular cells reacted differently to stains than the nuclei of the oocyte.

In a long and detailed paper, Branca (1925) described the various types of chromatic figures of maturation and segmentation stages which were found among a large collection of mouse, rabbit and guinea pig ovaries. He concluded that failure to distinguish between maturation and the first cleavage mitoses had led to much confusion in interpretation.

Kampmeier (1929) reviewed several of the outstanding contributions which have dealt with the "parthenogenetic" or atretic follicle and has added his own description of 24 ovaries of dogs. He concludes that the evidence offered for the occurrence of true parthenogenesis in mammals is extremely scanty.

From a summary of these 100 inbred tissues it is seen that the grouping of animals according to age is only a relative index of the structural condition of the ovaries. The occurrence of corpora lutea is found in the youngest individuals of this series, 49 days, but 11 individuals among the 33 animals younger than 84 days do not contain these structures. In the groups older than 84 days, corpora lutea are present with only 6 exceptions up to the oldest individuals (461, 524 and 537 days) where they are again absent. The absence of corpora lutea in a single ovary would not, therefore, necessarily be evidence of an induced change over the normal condition of the stock, but the absence of these structures between the ages of 84 and 443 days is not commonly encountered.

Follicles in various stages of development are found in each of the ovaries studied. No absolute quantitative analysis was made since such a count would have no value unless the phase of the estrous cycle, size and age of a large number of the individual tissues were the same. A relative quantitative analysis shows the primary follicles to be much more numerous in the 49 to 100 day old group than in any other. An irregular occurrence of many of these primary follicles was also observed in several individuals of the older age groups. No regularity in number of secondary and

tertiary follicles was found. The greatest apparent production of the older type of follicle was seen to occur between 100 and 300 days. After 300 days of age, the tendency for a reduction in follicles is marked, but the presence of many secondary and tertiary follicles in ovaries of 324, 346, 367, 434 and 443 days of age makes it impossible to attempt a definite structural classification on an age basis.

Degenerating follicles and their remnants form an important phase in the study of these control ovaries. The type of degeneration reported by the authors just cited is similar to that which is found in this analysis. Figure 1 gives a series of camera lucida drawings showing the various stages in the degeneration of a follicle which has reached the secondary stage in development. These degeneration pictures are most marked in the groups 49 to 100, and 200 to 300 days of age. The smaller size of the ovaries in the younger group makes the zona pellucida remnants lie close together and occupy a prominent part in the medullary portion of the glands. With the enlargement of the ovary more stroma tissue comes to separate these elements so that the prominence of the degeneration products is diminished, although they are equally as numerous. In the ovaries 200 to 300 days of age, the degenerating follicles number 20 or more in a section. As the stroma becomes more fibrous in the older tissues, 300 days and older, the degenerating follicles become more widely separated, and in many sections are entirely lacking.

A second type of degeneration follows when follicles have reached the tertiary stage of development. Figure 6 shows one of the early stages; Figure 7, the ultimate stage in this type of degeneration. The oocyte, instead of retaining the thickened zona pellucida, loses this structure and very rapidly degenerates and disappears. The membrana granulosa and theca cells migrate into the antrum and ultimately fill this space, forming a vacuolated area which is surrounded by stroma tissue elements. This second type of degeneration occurs chiefly in the older ovaries, 300 days and older, with occasional occurrence among ovaries as young as 200 days of age.

The size of the mouse ovaries studied is perhaps the greatest variable encountered. Even in the youngest group of animals, the size of the gland could not be correlated with the age. When corpora lutea were present, these structures made a marked enlargement. The presence of a cyst at the hilum of a gland, in many cases caused a marked enlargement, so that size gave no index as to the degree of follicular activity or as to the age of the individual. In regard to comparison of the two ovaries from the same individual, the variation was equally as great as was found among different individuals. Both ovaries from the same animal were not sectioned except when a marked difference in size made this seem advisable. Exceptions to this last statement (ovaries 3512, right and left, and 2612 right and left) were cases where one ovary was removed by operation and the other removed at a later date when the animal was killed.

Among the older ovaries, 300 days and older (with the exception of 174 and 204 day individuals), the germinal epithelium was observed to contain areas of invagination. These epithelial ingrowths, in cross-section, appear ring-like and resemble the "anovular" follicles which have been observed by other authors. The epithelial rings in these control tissues are associated closely with normal primary follicles and are easily differentiated.

The occurrence of 33 epithelium-lined cysts among 100 ovaries chosen at random from stock animals, makes the histogenesis and functional significance of these structures worthy of brief consideration.

In each case these cysts are unilocular and show no signs of malignancy. They resemble the cystadenomata, one type of benign tumor which is said to constitute between 70 and 80 per cent of all ovarian tumors in the human (Lynch and Maxwell, 1922), and the epithelium, in the majority of cases, appears to be of the pseudomuci-

nous type. An analysis of the various sizes, positions and types of epithelium which line this particular group of cysts, seems to warrant the conclusion that they may originate either from germinal epithelium or oviduct epithelium, and are not derived from the follicular or corpora luteal elements.

The invagination and inclusion of germinal epithelium was traced in early stages of cyst formation. In ovary 6844, 236 days, the cyst epithelium and germinal epithelium show a persistent continuity through a small opening. Upon becoming encysted, the germinal epithelium appears more cuboidal, with the nuclei more widely separated, rounded, and centrally located in the cells. Upon enlargement of the cyst, the epithelium is flattened, due to pressure and increase of surface and, in some of the large cysts, becomes squamous in type.

The small cysts in young ovaries and the majority of those in older ovaries have a position and epithelial structure which indicates that the origin was from a portion of the oviduct. Presence of cilia and regions of papillation help to substantiate this assumption, although direct continuity between cyst epithelium and oviduct epithelium was not observed.

Blood elements and mucus are present in all but a few of the cysts. Ovary 6842, 236 days, contains a cyst filled with large, luteal-like cells. This cyst is presumably of oviduct-epithelium origin and the cells inclosed are thought to be lining epithelial cells which have loosened and become vacuolated.

Since these cysts were not associated with absence of corpora lutea except in one case (3590, 83 days), and since much evidence of active ovulation is observed in ovaries containing large cysts, it seems justifiable to assume that these cysts do not generally hinder the normal cytogenetic function of the glands.

## ROENTGEN-RAY APPARATUS AND DOSAGE

The "r" employed as a unit of dosage in these experiments is identical with the International "r". The radiation was delivered by a transformer, disc rectified. An air cooled, deep therapy tube running at 130 kv. and 5 ma. was used. The skin toleration dose (Hickey, Pohle, Lindsay and Barnes, 1929) for this quality lies between 200 and 300 r. (This corresponds to an average skin erythema dose.)

Two qualities of radiation were used:

(A) without filter, half-value layer in Al, 1.4 mm., half-value layer in Cu, 0.04 mm. The rate of application with this quality was 130 R/m.

(B) with 1 mm. Al filter, half-value layer in Al, 2.5 mm., half-value layer in Cu, 0.08 mm., effective wave length in Al, 0.37 Å. The rate of application with this quality was 27 R/m (Pohle and Barnes, 1928).

Some of the larger doses (1800 r) were administered at a rate of 60 R/m by lessening the target distance from 45 to 30 cm.

One hundred and ninety-five mice are included in the experimental groups of animals which were subjected to the roentgen rays. Of this number, 69 were exposed to a dosage of 27 r, 87 to 54 r, 6 to 150 r, 6 to 300 r, 6 to 500 r, 10 to 1800 r, of quality as given in "B". Eleven mice were subjected to 300 r of quality as given in "A".

## METHOD OF APPLICATION

The methods employed in administering the roentgen dosages were carefully executed in order to insure uniformity and make duplication possible.

The 156 mice which were exposed to 27 and 54 r were irradiated separately and with a single dose. Each mouse was placed ventral side downward, feet tied by means of a coarse string, and a broad ribbon strapped over the back so that no movement was possible. Figure 10*a* shows one of these mice fastened down and ready for application of the rays. When firmly fastened, the animal was arranged so as to lie in the center of the irradiation field. A sheet of lead 4 mm. in thickness was placed on blocks and interposed between the roentgen tube and the mouse, a distance of about 3 cm. above the top surface of the

box on which the mouse was fastened. An opening in the lead sheet, 3×5 cm., was arranged so that only the lumbodorsal region of the animal was exposed. By observations made in numerous dissections of mice specimens, the ovaries were known to be located inside the irradiated area.

The 28 mice which received 150, 300, 500 and 1800 r were put in celluloid tubes and arranged so that the caudal half of 6 animals could be placed under the opening in a lead plate and exposed at one time. Figure 10*b* shows a photograph of a mouse in one of the celluloid tubes ready for exposure to the rays. Due to the reflecting surface of the celluloid, a clear picture was impossible. The photograph gives a general idea of the procedure and shows the position of the animals while the exposure was given. The line, A——A, represents the edge of the lead plate and shows the anterior extent of irradiated surface. The tubes were constructed with flat bases, tapering front ends, and guards on the sides to prevent rotation, so that the mice were held firmly and the regional application was uniform. These tubes have proved very satisfactory in holding the mice in position without causing them any apparent discomfort. Paralysis of the limbs did not occur, even during long exposures, as it did when the animals were tied by means of strings.

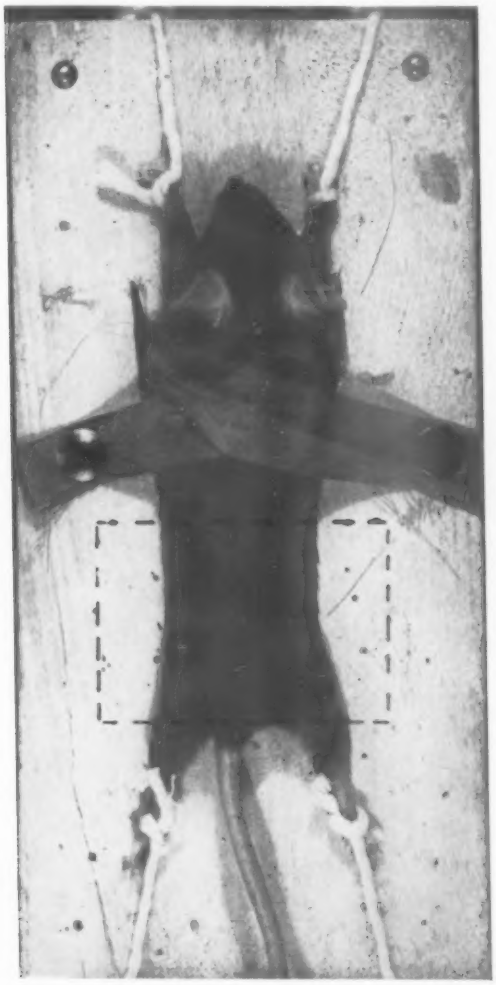


Fig. 10*a*. A mouse tied down for roentgen irradiation. This method was used for the mice which were exposed to 27 and 54 r. During exposure a lead shield covered the animal except over the lumbodorsal area. The exposed area is shown by the broken outline.

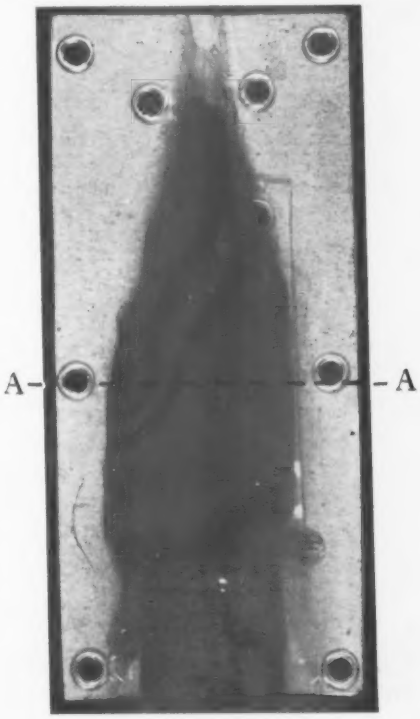



Fig. 10*b*. This type of celluloid tube was used for holding the mice when large doses were given. Six animals were arranged at one time under a square opening in a lead shield so that the caudal portion of each individual was exposed. The broken line shows the anterior extent of the exposed area.

DETAIL OF ANIMALS IRRADIATED

Charts II to X show the pedigrees of the animals which were irradiated. The serial number of each animal represented is inclosed in a trapezoid.

Tables III to V give the detail for each animal: letter designating the pedigree line, serial number, date of birth, date of irradiation, date of death, age in days when irradiated, age in days when killed, and the number of days between irradiation and death.

TABLE III

DETAIL OF ANIMALS EXPOSED TO 27 r

| Serial Number | Date of Birth | Date of Irradiation | Date Killed | Age in Days when Irradiated | Age in Days when Killed | No. Days between Irradiation and Death |
|---|---|---|---|---|---|---|
| D 2136 | 4/21/27 | 7/1/28 | 7/ 2/28 | 437 | 438 | 1 |
| A 3446 | 8/31/27 | " | " | 305 | 306 | 1 |
| C 4235 | 11/19/27 | 7/8/28 | 7/ 9/28 | 232 | 233 | 1 |
| A 4584 | 12/13/27 | " | " | 208 | 209 | 1 |
| C 5288 | 2/ 5/28 | " | " | 154 | 155 | 1 |
| D 5857 | 3/10/28 | " | " | 120 | 121 | 1 |
| C 6155 | 3/25/28 | " | " | 105 | 106 | 1 |
| A 6604 | 4/25/28 | " | " | 74 | 75 | 1 |
| A 4174 | 11/ 8/27 | " | 7/10/28 | 243 | 245 | 2 |
| D 4865 | 1/ 7/28 | " | " | 183 | 185 | 2 |
| C 5092 | 1/25/28 | " | " | 165 | 167 | 2 |
| C 6113 | 3/20/28 | " | " | 110 | 112 | 2 |
| A 6607 | 4/25/28 | " | " | 74 | 76 | 2 |
| C 2817 | 7/ 9/27 | 7/1/28 | 7/ 4/28 | 358 | 361 | 3 |
| A 3589 | 9/11/27 | " | " | 294 | 297 | 3 |
| D 1933 | 4/ 8/27 | " | 7/ 5/28 | 450 | 454 | 4 |
| D 3503 | 9/ 3/27 | " | " | 302 | 306 | 4 |
| F 4133 | 11/ 3/27 | 7/8/28 | 7/12/28 | 248 | 252 | 4 |
| C 4420 | 12/ 3/27 | " | " | 218 | 222 | 4 |
| D 5215 | 1/30/28 | " | " | 160 | 164 | 4 |
| D 5216 | " | " | " | 160 | 164 | 4 |
| D 5607 | 2/23/28 | " | " | 136 | 140 | 4 |
| C 6169 | 3/25/28 | " | " | 105 | 109 | 4 |
| D 6513 | 4/17/28 | " | " | 82 | 86 | 4 |
| A 2666 | 6/23/27 | 7/1/28 | 7/ 9/28 | 374 | 382 | 8 |
| D 3939 | 10/12/27 | " | " | 263 | 271 | 8 |
| D 4278 | 11/21/27 | 7/8/28 | 7/16/28 | 230 | 238 | 8 |
| C 5084 | 1/24/28 | " | " | 166 | 174 | 8 |
| D 6380 | 4/ 7/28 | " | " | 92 | 100 | 8 |
| C 3109 | 8/ 5/27 | 7/1/28 | 7/17/28 | 331 | 347 | 16 |
| B 3422 | 8/29/27 | " | " | 307 | 323 | 16 |
| B 4307 | 11/23/27 | 7/8/28 | 7/24/28 | 228 | 244 | 16 |
| C 5033 | 1/21/28 | " | " | 169 | 185 | 16 |
| B 5178 | 1/28/28 | " | " | 162 | 178 | 16 |
| C 5474 | 2/18/28 | " | " | 141 | 157 | 16 |
| D 6104 | 3/20/28 | " | " | 110 | 126 | 16 |
| A 6545 | 4/19/28 | " | " | 80 | 96 | 16 |
| D 2132 | 4/21/27 | 7/1/28 | 8/ 2/28 | 437 | 469 | 32 |
| A 3443 | 8/31/27 | " | " | 305 | 337 | 32 |
| C 4937 | 1/15/28 | 7/8/28 | 8/ 9/28 | 175 | 207 | 32 |
| D 5222 | 1/30/28 | " | " | 160 | 192 | 32 |
| D 5609 | 2/23/28 | " | " | 136 | 168 | 32 |
| D 6314 | 4/ 3/28 | " | " | 96 | 128 | 32 |

TABLE III (*Cont.*)
DETAIL OF ANIMALS EXPOSED TO 27 r

| Serial Number | Date of Birth | Date of Irradiation | Date Killed | Age in Days when Irradiated | Age in Days when Killed | No. Days between Irradiation and Death |
|---|---|---|---|---|---|---|
| C 6184 | 3/26/28 | " | " | 104 | 136 | 32 |
| C 6350 | 4/ 6/28 | " | 8/30/28 | 93 | 146 | 53 |
| B 3573 | 9/10/27 | 7/1/28 | 8/25/28 | 295 | 350 | 55 |
| D 2134 | 4/21/27 | " | 9/ 3/28 | 437 | 501 | 64 |
| E 4458 | 12/ 7/27 | 7/8/28 | 9/10/28 | 214 | 278 | 64 |
| C 4547 | 12/10/27 | " | " | 211 | 275 | 64 |
| B 5180 | 1/28/28 | " | " | 162 | 226 | 64 |
| D 6317 | 4/ 3/28 | " | " | 96 | 160 | 64 |
| C 3404 | 8/28/27 | 7/1/28 | 9/ 3/28 | 308 | 372 | 64 |
| C 3014 | 7/27/27 | " | 9/15/28 | 340 | 416 | 76 |
| D 2374 | 5/16/27 | " | " | 412 | 488 | 76 |
| C 5103 | 1/26/28 | 7/8/28 | 12/ 5/28 | 164 | 314 | 150 |
| C 5639 | 2/24/28 | " | " | 135 | 285 | 150 |
| C 5919 | 3/13/28 | " | " | 117 | 267 | 150 |
| D 6130 | 3/23/28 | " | " | 107 | 257 | 150 |
| C 6176 | 3/26/28 | " | " | 104 | 254 | 150 |
| C 2906 | 7/18/27 | 7/1/28 | " | 349 | 506 | 157 |
| E 6193 | 3/26/28 | 7/8/28 | 1/19/29 | 104 | 299 | 195 |
| D 3437 | 8/30/27 | 7/1/28 | " | 306 | 508 | 202 |
| E 3812 | 9/30/27 | " | " | 275 | 477 | 202 |
| C 4350 | 11/26/27 | 7/8/28 | 2/ 9/29 | 225 | 441 | 216 |
| D 4111 | 11/ 2/27 | " | " | 249 | 465 | 216 |
| C 4575 | 12/12/27 | " | " | 209 | 425 | 216 |
| C 6353 | 4/ 6/28 | " | " | 93 | 309 | 216 |
| C 6371 | 4/ 7/28 | " | " | 92 | 308 | 216 |
| D 3498 | 9/ 3/27 | 7/1/28 | " | 302 | 525 | 223 |

TABLE IV
DETAIL OF ANIMALS EXPOSED TO 54 r

| Serial Number | Date of Birth | Date of Irradiation | Date Killed | Age in Days when Irradiated | Age in Days when Killed | No. Days from Irradiation to Death |
|---|---|---|---|---|---|---|
| C 2032 | 4/14/27 | 6/23/28 | 6/24/28 | 436 | 437 | 1 |
| C 2669 | 6/23/27 | " | " | 366 | 367 | 1 |
| B 3421 | 8/29/27 | " | " | 299 | 300 | 1 |
| B 4305 | 11/23/27 | 6/24/28 | 6/25/28 | 214 | 215 | 1 |
| C 5083 | 1/24/28 | " | " | 152 | 153 | 1 |
| E 5167 | 1/28/28 | " | " | 148 | 149 | 1 |
| D 5634 | 2/24/28 | " | " | 121 | 122 | 1 |
| A 5967 | 3/17/28 | 7/ 1/28 | 7/ 2/28 | 106 | 107 | 1 |
| C 6303 | 4/ 3/28 | " | " | 89 | 90 | 1 |
| D 2181 | 4/26/27 | 6/23/28 | 6/25/28 | 424 | 426 | 2 |
| C 3090 | 8/ 3/27 | " | " | 325 | 327 | 2 |
| B 3575 | 9/10/27 | " | " | 287 | 289 | 2 |
| C 4393 | 12/ 1/27 | 6/24/28 | 6/26/28 | 206 | 208 | 2 |
| D 4864 | 1/ 7/28 | " | " | 169 | 171 | 2 |
| C 5354 | 2/12/28 | " | " | 133 | 135 | 2 |

TABLE IV (*Cont.*)

DETAIL OF ANIMALS EXPOSED TO 54 r

| Serial Number | Date of Birth | Date of Irradiation | Date Killed | Age in Days when Irradiated | Age in Days when Killed | No. Days from Irradiation to Death |
|---|---|---|---|---|---|---|
| F 5798 | 3/ 7/28 | " | " | 109 | 111 | 2 |
| C 6168 | 3/25/28 | 7/ 1/28 | 7/ 4/28 | 98 | 101 | 3 |
| E 6428 | 4/ 9/28 | " | " | 83 | 86 | 3 |
| C 2949 | 7/24/27 | 6/23/28 | 6/27/28 | 335 | 339 | 4 |
| A 3450 | 8/31/27 | " | " | 297 | 301 | 4 |
| F 4136 | 11/ 3/27 | 6/24/28 | 6/28/28 | 234 | 238 | 4 |
| D 4817 | 1/ 4/28 | " | " | 172 | 176 | 4 |
| C 5093 | 1/25/28 | " | " | 151 | 155 | 4 |
| D 5853 | 3/10/28 | " | " | 106 | 110 | 4 |
| C 5920 | 3/13/28 | 7/ 1/28 | 7/ 5/28 | 110 | 114 | 4 |
| D 6316 | 4/ 3/28 | " | " | 89 | 93 | 4 |
| C 2587 | 6/11/27 | 6/23/28 | 7/ 1/28 | 378 | 386 | 8 |
| E 3117 | 8/ 7/27 | " | " | 321 | 329 | 8 |
| A 3588 | 9/11/27 | " | " | 286 | 294 | 8 |
| C 4036 | 10/23/27 | 6/24/28 | 7/ 2/28 | 245 | 253 | 8 |
| D 5072 | 1/25/28 | " | " | 151 | 159 | 8 |
| D 5221 | 1/30/28 | " | " | 146 | 154 | 8 |
| C 5505 | 2/19/28 | " | " | 126 | 134 | 8 |
| A 6179 | 3/26/28 | 7/ 1/28 | 7/ 9/28 | 97 | 105 | 8 |
| D 6516 | 4/17/28 | " | " | 75 | 83 | 8 |
| D 6379 | 4/ 7/28 | " | 7/11/28 | 85 | 95 | 10 |
| C 2913 | 7/18/27 | 6/23/28 | 7/ 4/28 | 341 | 352 | 11 |
| A 3373 | 8/26/27 | " | " | 302 | 313 | 11 |
| D 1934 | 4/ 8/27 | " | 7/ 9/28 | 442 | 458 | 16 |
| C 3108 | 8/ 5/27 | " | " | 323 | 339 | 16 |
| B 3423 | 8/29/27 | " | " | 299 | 315 | 16 |
| C 4381 | 11/28/27 | 6/24/28 | 7/10/28 | 209 | 225 | 16 |
| C 4574 | 12/21/27 | " | " | 186 | 202 | 16 |
| B 5179 | 1/28/28 | " | " | 148 | 164 | 16 |
| C 5725 | 2/28/28 | " | " | 117 | 133 | 16 |
| C 6114 | 3/20/28 | 7/ 1/28 | 7/17/28 | 103 | 119 | 16 |
| A 6546 | 4/19/28 | " | " | 73 | 89 | 16 |
| D 3094 | 8/ 3/27 | 6/23/28 | 7/25/28 | 325 | 357 | 32 |
| C 3405 | 8/28/27 | " | " | 300 | 332 | 32 |
| E 3810 | 9/30/27 | " | " | 267 | 299 | 32 |
| C 4446 | 12/ 7/27 | 6/24/28 | 7/26/28 | 200 | 232 | 32 |
| D 4867 | 1/ 7/28 | " | " | 169 | 201 | 32 |
| C 5182 | 1/29/28 | " | " | 147 | 179 | 32 |
| C 5356 | 2/12/28 | " | " | 133 | 165 | 32 |
| C 6165 | 3/25/28 | 7/ 1/28 | 8/ 2/28 | 98 | 130 | 32 |
| C 6181 | 3/26/28 | " | " | 97 | 129 | 32 |
| C 6299 | 4/ 3/28 | " | " | 89 | 121 | 32 |
| D 5608 | 2/23/28 | 6/24/28 | 7/28/28 | 122 | 156 | 34 |
| B 6632 | 4/29/28 | 7/ 1/28 | 8/27/28 | 63 | 120 | 57 |
| C 2816 | 7/ 9/27 | 6/23/28 | 8/26/28 | 350 | 414 | 64 |
| C 3644 | 9/14/27 | " | " | 283 | 347 | 64 |
| C 5034 | 1/21/28 | 6/24/28 | 8/27/28 | 155 | 219 | 64 |
| A 5136 | 1/27/28 | " | " | 149 | 213 | 64 |
| D 5610 | 2/23/28 | " | " | 122 | 186 | 64 |
| D 5630 | 2/24/28 | " | " | 121 | 185 | 64 |
| E 5914 | 3/13/28 | 7/ 1/28 | 9/ 3/28 | 110 | 174 | 64 |

TABLE IV (*Cont.*)
DETAIL OF ANIMALS EXPOSED TO 54 r

| Serial Number | Date of Birth | Date of Irradiation | Date Killed | Age in Days when Irradiated | Age in Days when Killed | No. Days from Irridation to Death |
|---|---|---|---|---|---|---|
| D 6108 | 3/20/28 | " | " | 103 | 167 | 64 |
| C 6372 | 4/ 7/28 | " | " | 85 | 149 | 64 |
| C 4161 | 11/ 6/27 | 6/24/28 | 11/10/28 | 231 | 370 | 139 |
| A 4173 | 11/ 8/27 | " | " | 229 | 368 | 139 |
| D 4949 | 1/16/28 | " | " | 160 | 299 | 139 |
| D 3501 | 9/ 3/27 | 6/23/28 | " | 294 | 434 | 140 |
| E 6225 | 3/29/28 | 7/ 1/28 | 12/ 5/28 | 94 | 251 | 157 |
| C 6354 | 4/ 6/28 | " | " | 86 | 243 | 157 |
| D 6103 | 3/20/28 | " | " | 103 | 260 | 157 |
| D 6132 | 3/23/28 | " | 12/10/28 | 100 | 262 | 162 |
| A 4583 | 12/13/27 | 6/24/28 | 12/ 5/28 | 194 | 358 | 164 |
| A 4585 | 12/13/27 | " | 12/17/28 | 194 | 370 | 176 |
| C 5095 | 1/25/28 | " | 1/12/29 | 151 | 353 | 202 |
| A 5138 | 1/27/28 | " | " | 149 | 351 | 202 |
| C 5277 | 2/ 4/28 | " | " | 141 | 343 | 202 |
| C 5640 | 2/24/28 | " | " | 121 | 323 | 202 |
| F 5801 | 3/ 7/28 | " | " | 109 | 311 | 202 |
| A 6340 | 4/ 5/28 | 7/ 1/28 | 2/ 9/29 | 87 | 310 | 223 |
| C 6352 | 4/ 6/28 | " | " | 86 | 309 | 223 |
| D 5855 | 3/10/28 | 6/24/28 | " | 106 | 336 | 230 |

TABLE V
DETAIL OF ANIMALS EXPOSED TO 150, 300, 500, AND 1800 r

| Dosage | Serial Number | Date of Birth | Date of Irradiation | Date Killed | Age in Days when Irradiated | Age in Days when Killed | No. Days from Irradiation to Death |
|---|---|---|---|---|---|---|---|
| | C 6159 | 3/25/28 | 12/20/28 | 12/22/28 | 270 | 272 | 2 |
| | C 6927 | 6/10/28 | " | 12/24/28 | 193 | 197 | 4 |
| 150 | E 6968 | 6/13/28 | " | 1/ 1/29 | 190 | 202 | 12 |
| | C 6803 | 5/25/28 | " | 1/10/29 | 209 | 230 | 21 |
| r | C 6674 | 5/ 3/28 | " | 2/ 1/29 | 231 | 274 | 43 |
| | A 7149 | 7/ 1/28 | " | " | 172 | 215 | 43 |
| | C 5475 | 2/18/28 | 12/20/28 | 12/22/28 | 306 | 308 | 2 |
| | A 4586 | 12/13/27 | " | 12/24/28 | 373 | 377 | 4 |
| | A 4321 | 11/25/27 | " | 1/ 1/29 | 391 | 403 | 12 |
| | A 6180 | 3/26/28 | " | 1/10/29 | 269 | 290 | 21 |
| | C 4347 | 11/26/27 | " | 2/ 1/29 | 390 | 433 | 43 |
| | C 6175 | 3/26/28 | " | " | 269 | 312 | 43 |
| | F 1347 | 1/ 4/27 | 6/13/27 | 1/27/28 | 160 | 388 | 228 |
| 300 | F 1550 | 2/ 6/27 | " | " | 127 | 355 | 228 |
| | F 1553 | " | " | " | 127 | 355 | 228 |
| r | D 1576 | 2/15/27 | " | " | 118 | 346 | 228 |
| | D 1578 | " | " | " | 118 | 346 | 228 |
| | D 1807 | 3/22/27 | " | " | 83 | 311 | 228 |
| | F 1349 | 1/ 4/27 | " | 2/22/28 | 160 | 414 | 254 |
| | D 1806 | 3/22/27 | " | " | 83 | 337 | 254 |

TABLE V (*Cont.*)
DETAIL OF ANIMALS EXPOSED TO 150, 300, 500, AND 1800 r

| Dosage | Serial Number | Date of Birth | Date of Irradiation | Date Killed | Age in Days when Irradiated | Age in Days when Killed | No Days from Irradiation to Death |
|---|---|---|---|---|---|---|---|
| | D 1892 | 4/ 1/27 | " | " | 73 | 327 | 254 |
| | D 1894 | " | " | " | 73 | 327 | 254 |
| | D 1895 | " | " | " | 73 | 327 | 254 |
| | C 4035 | 10/23/27 | 12/20/28 | 12/22/28 | 424 | 426 | 2 |
| | E 4459 | 12/ 7/27 | " | 12/24/28 | 379 | 383 | 4 |
| 500 | C 5355 | 2/12/28 | " | 1/ 1/29 | 312 | 324 | 12 |
| | D 5338 | 2/10/28 | " | 1/10/29 | 314 | 335 | 21 |
| r. | D 5069 | 1/25/28 | " | 2/ 1/29 | 330 | 373 | 43 |
| | A 6289 | 4/ 2/28 | " | " | 262 | 305 | 43 |
| | D 7274 | 8/18/28 | 1/10/29 | 1/11/29 | 145 | 146 | 1 |
| | D 6695 | 5/ 8/28 | 1/31/29 | 2/ 3/29 | 268 | 271 | 3 |
| | C 5360 | 2/12/28 | 1/31/29 | 2/ 4/29 | 354 | 358 | 4 |
| | C 6749 | 5/18/28 | 1/10/29 | 1/14/29 | 237 | 241 | 4 |
| 1800 | C 6811 | 5/25/28 | " | " | 230 | 234 | 4 |
| | D 6917 | 6/ 9/28 | " | " | 215 | 219 | 4 |
| r. | D 6698 | 5/10/28 | 1/31/29 | 2/ 4/29 | 266 | 270 | 4 |
| | C 7132 | 6/27/28 | 1/10/29 | 1/14/29 | 197 | 201 | 4 |
| | D 5337 | 2/10/28 | 1/31/29 | 2/ 5/29 | 356 | 361 | 5 |
| | D 5336 | " | " | " | 356 | 361 | 5 |

### POST-IRRADIATION CARE OF ANIMALS

Following exposure to roentgen rays, the mice were kept in large pens in groups of 12 animals each. The animals remained in good physical condition with no visible reaction to the treatment. The individuals which received massive doses of 1800 r were an exception to this statement. Death occurred in about four days after this exposure. The animals presented the symptoms of an acute diarrhea apparently due to a damage of the intestinal mucosa in the irradiated area.

As is pointed out in the tables showing the detail of the irradiated animals, ovarian tissue was removed at different post-irradiation intervals, the shortest period being 24 hours after exposure to the rays, the longest being 254 days. For the most part, females which were noticeably pregnant at time of irradiation were killed in the groups with the shorter post-irradiation intervals. A few were allowed to come to full term and the progeny are under observation in a study of the biologic phase of the work.

Eighteen days after irradiation, a normal male animal was added to each pen. These males had been previously proved fertile by matings with stock animals. The progeny of the matings of these males with the irradiated females are also under observation in the biologic phase of the work referred to above.

### METHOD OF OBTAINING AND PREPARING TISSUES

In order to obtain the tissues with as little post-mortem change as possible, the mice were killed by placing them in a glass cylinder containing coal gas under pressure. As soon as the animal was dead its head was severed from its body to allow free bleeding and the ovaries were removed at once by abdominal incision.

Carnoy's mixture was used as a fixative. This is an anhydrous mixture of absolute alcohol (60 parts), chloroform (30

parts), and glacial acetic acid (10 parts), which has been found an excellent fixation for embryonic tissue and gives very little shrinkage. The tissues were left in this fixative for five to ten hours with frequent shaking, and then transferred to absolute alcohol.

After thorough dehydration in absolute alcohol, the tissues were cleared with xylol during four to six hours and transferred to soft paraffin for two to three hours, at 56° C. They were then placed in hard paraffin for four to five hours and finally imbedded in paraffin blocks.

The sections were cut on a rotary microtome at a uniform thickness of 8 micra. The slides (2×3 cm.) were covered with a thin film of albumin-glycerine mixture. The paraffin strips were floated in distilled water on the glycerine-coated slides and stretched on a Huber section stretcher. When thoroughly stretched and arranged, the sections were allowed to attach firmly to the slide and were then placed in a drying oven and kept at 38° C. for about three days.

When ready for staining, the paraffin was melted from around the sections by holding the slides above a gas flame and the melted paraffin was then dissolved by washing in two changes of xylol. The xylol was removed by rinsing in two changes of 95 per cent alcohol, 70 per cent alcohol, and finally 35 per cent alcohol.

After overstaining for 10 to 20 minutes in Mayer's hematoxylin, the sections were washed in two changes of distilled water, 35 per cent alcohol and 70 per cent alcohol, and then decolorized in 0.5 per cent acid alcohol. They were then washed in 70 per cent alcohol, 35 per cent alcohol, distilled water, and finally in filtered tap water, until the desired change to blue was obtained. After washing in two changes of distilled water, they were placed in Congo-red (Huber) for two to five hours.

Upon removal from the Congo-red stain, the sections were washed in two to three changes of distilled water, 35 per cent alcohol, 70 per cent alcohol and 95 per cent alcohol. They were then placed in two changes of carbol-xylol for five to ten minutes, then in two changes of xylol, and from the xylol were mounted in Canada balsam.

## EXPERIMENTAL FINDINGS

*Animals Exposed to 27 r.* Careful examination of the ovaries from the 69 animals which were subjected to a dose of 27 r, revealed no evidence of a direct effect on the normal structural elements. Compared with control tissues of the same age, the group representing post-irradiation intervals from one to 53 days (see Table III) presented no marked differences. In the groups with longer post-irradiation intervals, however, several ovaries were found in which atypical structure and arrangement of the tissues warrant a further description.

The ovary of female 3573, 350 days old, 55 days after irradiation, is not normal for the age. The follicles are relatively scarce, less than 20 of the primary type being present in the entire gland, while more advanced types are even less numerous. Corpora lutea are present at one pole, with large areas of fatty degeneration around the cortical zone and in the medulla. The germinal epithelium is invaginated into the thickened tunica albuginea in a number of regions, with numerous anovular rings associated with these areas. A few zona pellucida remnants are scattered through the gland; late stages of degeneration of the older types of follicles, separated by areas of fatty degeneration, are seen around the periphery. The medulla and much of the cortex is filled with epithelial cells which are held in irregular shaped areas by the fibrous tissue of the stroma. Blood vessels with thickened walls are seen spread through the medullary region. Figure 11 shows a portion of this gland.

The ovary of female 2134, 501 days old, 64 days after irradiation, is atypical. The cysts found in this gland have crowded the ovarian tissue off to one side and strands of tissue extend into pieces of cyst walls, the cysts having joined, and left fragments among the blood elements which fill the antra. Figure 12 gives a portion of one section from this gland.

Both ovaries of female 3404, 372 days old, 64 days after irradiation, are found to be atypical.

The right gland is incorporated with the oviduct and part of the uterine horn, so that

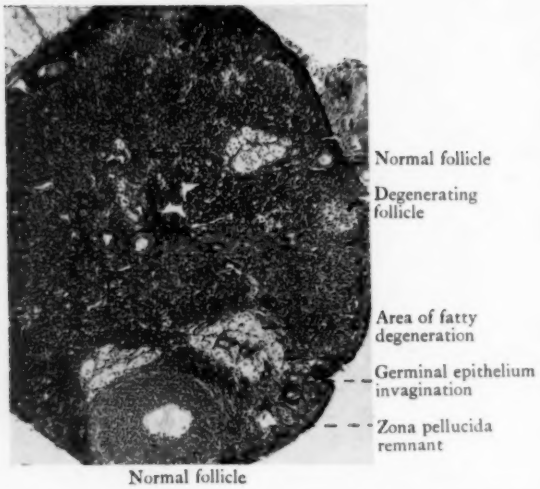



FIG. 11. Ovary 3573, 350 days old, 55 days after irradiation showing invagination of germinal epithelium with anovular rings and thickened tunica albuginea, two normally developing and two degenerating follicles. The interfollicular tissue is densely fibrous, with scattered areas of fatty degeneration and numerous blood vessels (×89).

it is almost entirely inclosed by these structures. The gland contains a large cyst with the ovarian tissue pushed to one side and forming a crescent-shaped mass at the periphery. Only a few primary and tertiary follicles are present. The secondary type of follicles is quite numerous, with many zona pellucida remnants from the degeneration of this developmental type. The interfollicular tissue resembles that shown in Figure 12, with the same fatty degeneration and small blood vessels scattered among the vacuolated cell areas. Figure 13 shows a portion of one section which contains structures typical of the whole gland.

The left gland also contains a cyst, but it is of small size. A few follicles in all stages of development are present. The periphery is markedly invaginated by germinal epithelium, while the medulla is rich in vacuolated cell elements.

FIG. 12. Ovary 2134, 501 days old, 64 days after irradiation. This section shows one of the few normal follicles which it contains. Zona pellucida remnants, areas of fatty degeneration and blood vessels are seen spread through the medulla. This is rich in vacuolated cells forming irregular areas which are surrounded by fibrous tissue of the stroma (×91).

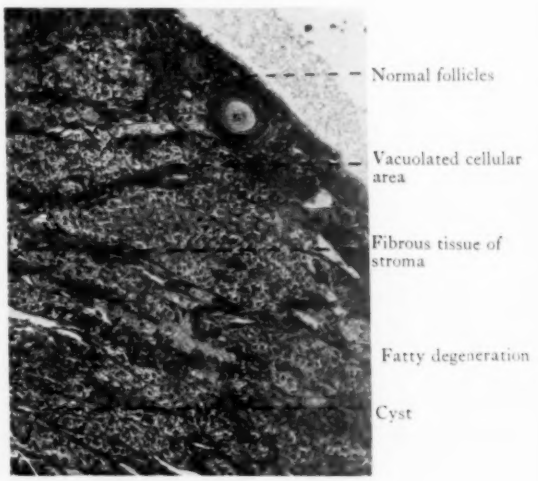



FIG. 13. Right ovary of 3404, 372 days old, 64 days after irradiation, showing two normal follicles, small areas of fatty degeneration, blood vessels and fibrous tissue of the stroma; also the vacuolated structure of the interfollicular cellular elements. A portion of the germinal epithelium and edge of the cyst are also indicated (×184).

The ovary of female 6176, 254 days old, 150 days after irradiation, shows normal structures for the age with the exception of the presence of marked germinal epithelium invagination and anovular rings. Figure 15 is a peripheral portion from a section of this gland.

The ovary of female 6193, 299 days old, 195 days after irradiation, is very much reduced in size and is inclosed in a fibromuscular capsule. A few normal follicles in the secondary stage of development are scattered through the gland, with a great many degeneration remnants in each section. The interfollicular tissue is

densely cellular and deeply stained, with numerous anovular rings in the cortex, and large blood vessels in the medulla. With the exception of the normal follicles, this gland is quite similar to those found among animals which were irradiated at a very early age and allowed to grow to maturity. It is quite probable that ovulation in such an ovary would be impossible. Figure 16 is a section of this gland which shows the structure just mentioned.

*Animals Exposed to 54 r.* Of the 87 animals exposed to 54 r, nine were killed one day after irradiation.

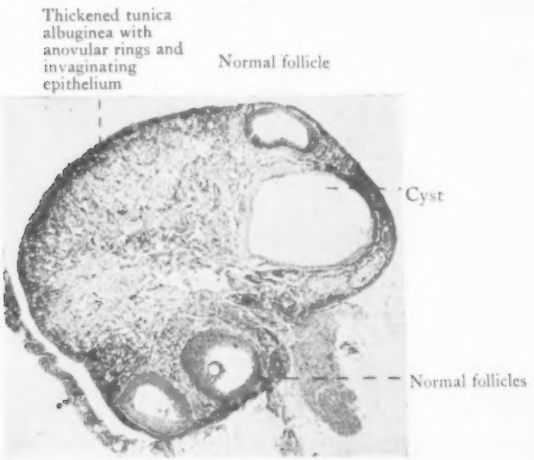



Fig. 14. Section from left ovary of female 3404, 372 days old, 64 days after irradiation, showing the marked germinal epithelium invaginations, thickened zona pellucida and anovular rings. Three normal graafian follicles are shown, and one of the primary type. The vacuolated structure of the medullary cellular elements is marked. Small areas of fatty degeneration, blood vessels, zona pellucida remnants and fibrous tissue of the stroma are scattered through this predominating medullary tissue (×44).

The ovaries from female 2032, 437 days old and female 2669, 367 days old, are normal for their age.

Ovary 3421, 300 days of age, is atypical in that extended areas of fatty degeneration fill up a large portion of the medulla, with many projections into the cortical zone between the follicles and corpora albicantia. Follicles of the primary type are almost entirely lacking; the few which remain, however, although widely separated are apparently normal. Many follicles in advanced stages of development and other normal elements which are typical for an

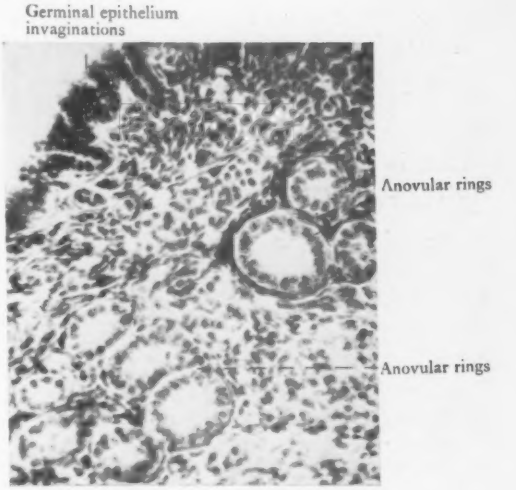



Fig. 15. A peripheral section from ovary 6176, showing an area of germinal epithelium invagination and nests of anovular rings in the tunica albuginea which is atypical for ovaries under 300 days of age (×450).

ovary of this age are found in the usual arrangement.

The remaining six ovaries in this group (Table IV) present a structure which has never been

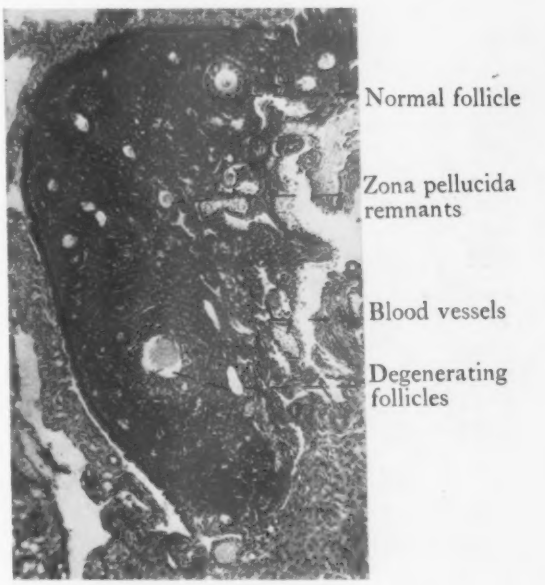



Fig. 16. (×114).

observed in any of the ovaries so far mentioned—a marked pycnosis of the nuclei of the oocytes in a large majority of the primary follicles. Other structures in the gland are apparently normal for the different ages represented.

Figures 17, 18 and 19 show very high magnifications of atypical follicles from three of these ovaries, while Figure 20 is a lower magnification from a fourth animal which shows a group of these structures in relation to normal appearing follicles in more advanced stages of development.

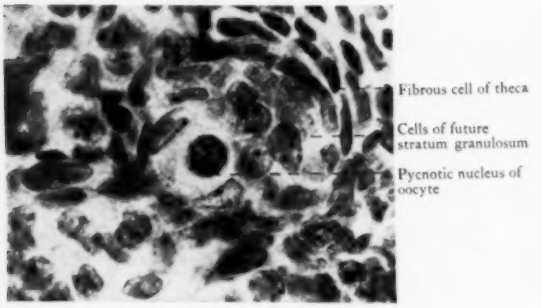



FIG. 17. A section from the ovary of female 4305, 215 days old, one day after exposure to 54 r, showing a single primary follicle in early stage of development. The cells of the initial row of stratum granulosum have begun to arrange around the oocyte, and fibrous cells are seen forming the first evidence of the theca layers. The nucleus of the oocyte is markedly pycnotic and deeply stained, an atypical occurrence at this early stage of development, and first observed among the ovaries exposed to this particular dosage and post-irradiation interval (×1800).

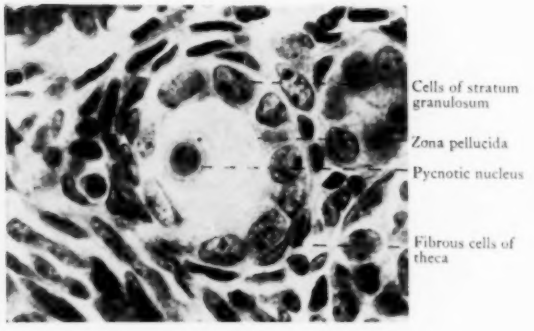



FIG. 18. A section from the ovary of female 5083, 153 days old, one day after exposure to 54 r, showing a single primary follicle of a slightly older stage of development than that shown in the last figure. The first row of follicular cells, the stratum granulosum, is almost complete, and a distinct layer of fibrous cells of the theca are seen surrounding it. The nucleus of the oocyte is pycnotic and essentially similar to that in the last figure. In addition, there is a clear zone around the nucleus and the zona pellucida begins to be evident around a portion of the periphery (×1800).

It will be noticed that these ovaries range in age between 90 and 215 days (90, 107, 122, 149, 153 and 215), and that the atypical oocytes are essentially the same in each gland. Further mention will be made of these structures in the discussion of their significance.

For direct comparison, Figure 21 shows a primary follicle at the same magnification as Figures 17, 18 and 19, which represents the type of structure observed in thousands of sections already mentioned as "normal" for these ovaries.

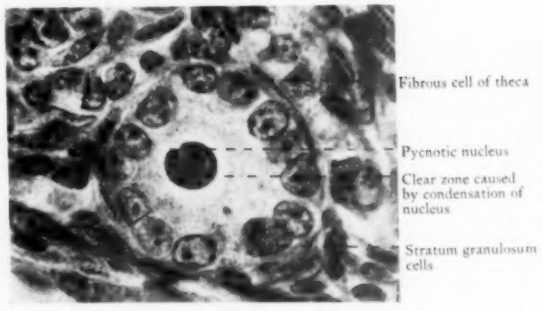



FIG. 19. A section from the ovary of female 5167, 149 days old, one day after exposure to 54 r, showing another primary follicle essentially similar to those in Figures 17 and 18. The nucleus of the oocyte is markedly pycnotic and a clear zone is formed around it as a result of the condensation (×1800).

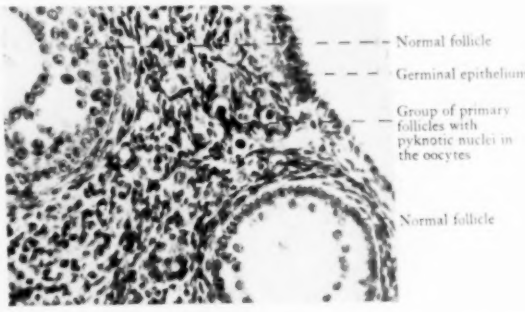



FIG. 20. A section from female 6303, 90 days old, one day after exposure to 54 r, showing a group of atypical primary follicles in relation to apparently normal follicles in older stages of development. The atypical structures at this magnification are clearly evident on comparison with the normal primary follicles of other ovaries (refer to Fig. 2, or Fig. 4) (×145).

Seven animals were killed two days after irradiation. Two of these, female 2181, 426 days, and female 3090, 327 days, show many anovu-

lar rings around the periphery of the ovary, but no normal primary follicles. Other structures are typical for the ages represented.

The ovary of female 3575, 289 days old, is apparently normal and has a few anovular rings in the periphery, which is typical for the age.

The other four ovaries in this group all show occasional pycnotic nuclei in the oocytes of the primary follicles. Ovary 4393, 208 days old, has very few normal primary follicles and numerous anovular rings. This same condition exists in ovary 4864, 171 days old. Ovary 5354, 135 days old, on the other hand, has many normal primary follicles and few anovular rings, while ovary 5798, 111 days old, has few normal primary follicles and few anovular rings. In this whole group, the only detectable changes are a total or partial disappearance of primary follicles and the persistence of anovular rings.

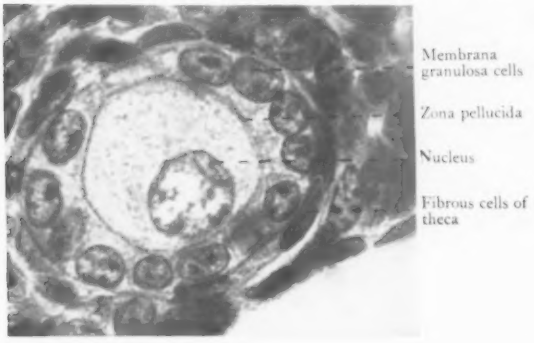



Fig. 21. A section from the ovary of female 7237, 174 days of age, which shows a primary follicle of one of the control tissues at the same magnification as Figures 17, 18 and 19. The structure of the oocyte is characteristic for the normal, with chromatin granules widely separated throughout the nucleus, and zona pellucida surrounding the oocyte and separating it from the single layer of membrana granulosa cells. As in the other figures, the fibrous cells of the theca have begun to form around the outside of the follicle (×1800).

The wide variation in number of normal primary follicles which remain is comparable to the variation in number of primary follicles originally present. Judging from a comparison with control ovaries of the same ages, the total absence of normal primary follicles from the two oldest of this group indicates an age susceptibility which was not evident among the ovaries of animals killed one day after irradiation. The ovary of female 3575, on the other hand, in this same relative age group, is apparently unaffected.

Ovary 6168, 101 days old, killed three days after irradiation, has no normal primary follicles and exhibits many anovular rings. Ovary 6428, 86 days old, is similar in these respects. On the other hand, it is composed almost entirely of large corpora lutea, while these structures in the former make up no more than a normal portion of the gland.

In the group of 8 females killed four days after irradiation, ovary 5093, 155 days old, and ovary 5920, 114 days old, show many anovular rings but no normal primary follicles. All the others are apparently normal for their ages except ovary 6316, 93 days old, which has the structural appearance of an older gland.

Nine animals were killed eight days after the irradiation. Of this number, 3 were apparently normal with no detectable changes in the ovaries. The remaining five ovaries show an atypical appearance of primary follicles, but are otherwise apparently normal. Ovary 2587, 386 days old, ovary 3588, 294 days old, and ovary 5221, 154 days old, lack these structures, while ovary 5505, 134 days old, and 6179, 105 days old, have very few normal follicles of this type. The ovary of female 6379, 95 days old, killed ten days after the irradiation, lacks normal primary follicles, while the ovaries of females 2913, 352 days old, and 3373, 313 days old, killed eleven days after irradiation, show the few normal primary follicles typical for their ages.

Ovaries of the 9 females killed sixteen days after irradiation (89 to 458 days of age), were structurally normal for the ages which they represent.

A number of ovaries from animals killed thirty-two days after irradiation, show marked atypical arrangement in their structure. Ovary 3810, 299 days old, has no normal primary follicles. The tunica albuginea is full of anovular rings, but the germinal epithelium is not markedly invaginated. Many degeneration remnants from follicles in advanced stages of development are present. The medulla is rich in epithelioid cellular elements and blood vessels. Corpora lutea are present.

Ovary 5182, 179 days old, contains no normal primary follicles. It shows marked degeneration of older follicles with many remnants of this process throughout the gland. Anovular rings are numerous in the cortical zone, while epithelioid cell areas constitute a major part of

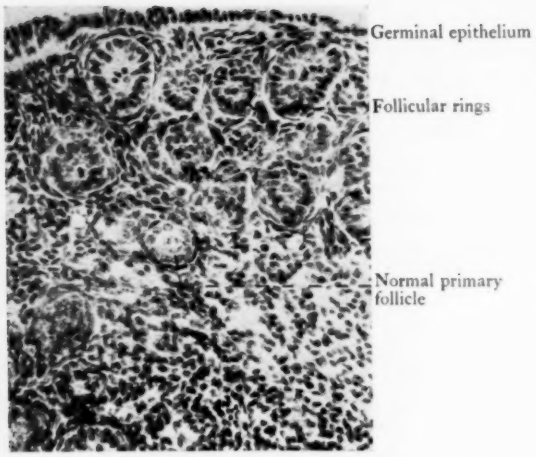



Fig. 22. A section from ovary 4173, 368 days old, 139 days after irradiation with 54 r, showing the cortical zone of anovular rings with one apparently normal primary follicle. This is the only follicle in the gland which contains an intact oocyte (×360).

the medulla. Large corpora albicantia are present.

Ovary 6165, 130 days old, is apparently normal except that no primary follicles are present.

Ovary 6299, 121 days old, has very few normal follicles. Many anovular rings are present in the tunica albuginea, while the medulla contains a good deal of the epithelioid structure as mentioned in connection with some of the foregoing glands.

In the 5 other ovaries which were killed after a post-irradiation period of 32 days, no changes from the normal are observed.

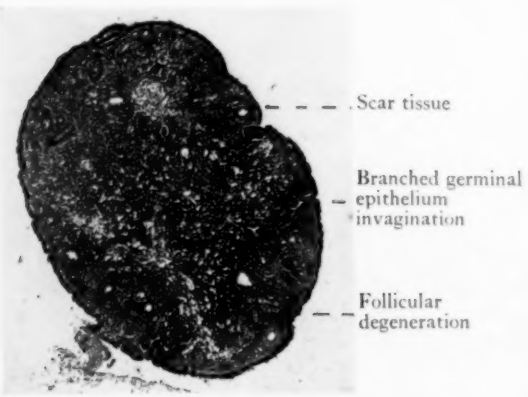



Fig. 23*a*. A whole section from the same ovary as that shown in Figure 22, showing the marked germinal epithelium invagination and the follicular degeneration remnants (×70).

Ovary 6632, 120 days old, fifty-seven days after irradiation, has no normal primary follicles. Anovular rings are numerous. Few normal follicles of older stages of development are present, but degenerative remnants of these structures are numerous. Large areas of epithelioid cells and of fatty degeneration are seen in the medulla.

Seven of the 9 animals killed sixty-four days after irradiation had ovaries which were apparently normal.

Ovary 5630, 185 days old, one of the atypical glands, is entirely lacking in normal follicles. The thin fibrous tunica albuginea contains many anovular follicle rings with luteal-like cells which give a uniform appearance to this part of the gland. Many zona pellucida remnants are found scattered through the common medullary structure.

Ovary 6108, 167 days of age, contains normal follicles of all types, but shows also a marked degeneration of many of these structures. The medulla is here again filled with epithelioid cell elements in alveolar arrangement.

Ovaries from the 18 animals which were killed between 139 and 229 days after the irradiation all show marked structural changes.

Of the 3 animals killed 139 days after the exposure, ovary 4161, 370 days old, shows a few normal follicles and corpora lutea still persisting. Spaces containing zona pellucida remnants are numerous and follicles in earlier stages of degeneration are present in a number of sections. The periphery shows a zone filled with rings of follicular epithelium, anovular and single-layered. In the hilum, a small cyst, lined with high columnar epithelium, is surrounded by ovarian structures.

Ovary 4173, 368 days old, contains hundreds

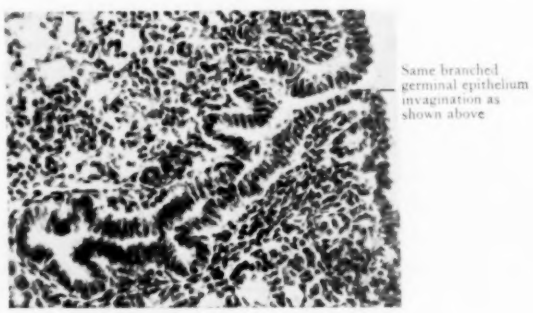



Fig. 23*b*. A higher magnification of part of this section to show a branched germinal epithelium invagination (×470).

of anovular rings but only one normal follicle. This is single-layered and contains an apparently normal oocyte (Fig. 22). The germinal epithelium of this ovary is very irregular, invaginating into the cortex and forming a zone of anovular follicle rings. This invagination varies in its form, being usually in a single tubular arrangement, but rarely branched in all directions (Figs. 23*a* and 23*b*). Zona pellucida remnants are numerous. As in the preceding ovary, a small cyst occurs in the hilum of the gland.

Ovary 4949 has one normal follicle in secondary stage of development. Anovular epithelial rings are numerous. Degenerating follicles and zona pellucida remnants are found throughout the gland. A large cyst, similar in structure to the two preceding, has pushed the ovarian elements off to one side, only thin bands of stromal tissue appearing around the periphery.

Female 3501, 434 days old, was killed after a post-irradiation period of 140 days. The ovary lacks normal follicles and shows a peripheral zone with anovular rings and transitions between follicular and stromal elements. A whole section from this gland shows the general appearance of these structures (Fig. 24*a*). The stromal tissue which extends toward the periphery forms fibrous trabeculae cutting the alveolar groups into either large or small areas. Follicular and corpora lutea elements appear to make up the new stroma in part. Transitional forms between follicular rings and the epithelioid elements of the alveoli are shown in Figure 24*b*. This figure also shows a germinal epithelium invagination and an anovular ring.

Three animals, females 6103, 6225, and 6354, were killed after a post-irradiation period of 157 days.

The ovary from female 6103, 260 days of age, is afollicular. Invaginating germinal epithelium forms a distinct zone of epithelial rings in a thickened tunica albuginea. Follicular cords or nests are numerous. These structures have a thin fibrous capsule which shows as a closed ring, or, in some cases, broken, the contained cells pushing out and mixing with the surrounding cellular elements. A corpus luteum persists near one pole of this gland. The stroma is alveolar in appearance and is grouped into areas quite similar to those in the preceding ovary. A few zona pellucida remnants are spread throughout the gland.

Ovary 6225, 251 days of age, has very much the same structural arrangement as that found in 6103. The early peripheral ingrowths of germinal epithelium, with follicular cords showing transitions of development, are features common to all sections. The gland is afollicular, and like others of this group, has a medulla filled with alveolar-like arrangement of epithelioid cell elements.

Ovary 6354, 243 days of age, is afollicular with peripheral zone and stroma which contain structures similar to the preceding. The formation of follicular cell nests is very marked (Fig. 25*a*). The stroma is luteal-like with less alveolar arrangement, and contains a great many zona pellucida remnants or empty antra (Fig. 25*b*).

Female 6132 was killed 162 days after exposure to the rays. The ovary shows a number of normal follicles in advanced stages of development. Corpora lutea and degenerating follicles break up the gland so that the periph-

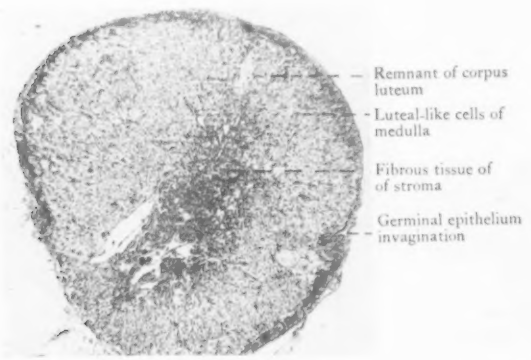



Fig. 24*a*. A whole section from ovary 3501, 434 days old, showing the general appearance of the gland (×50).

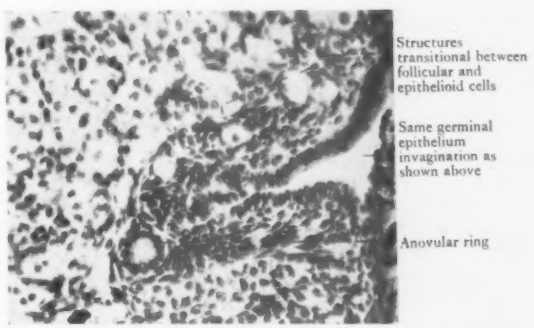

Structures transitional between follicular and epithelioid cells
Same germinal epithelium invagination as shown above
Anovular ring

Fig. 24*b*. A higher magnification of a portion of this section to show the invagination of germinal epithelium and structure of the medullary elements (×470).

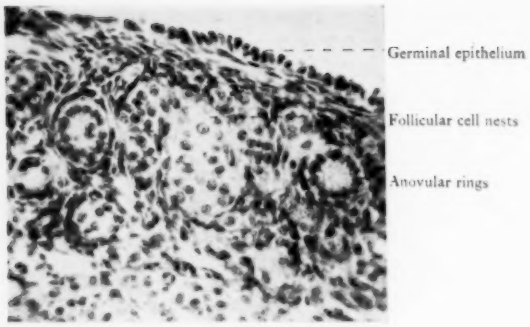



FIG. 25*a*. A peripheral portion of a section from ovary 6354, 243 days old, to show the cortical zone containing anovular rings and follicular cell nests (×470).

eral zoning is not distinct but tunica albuginea containing nests of follicular cells are present in the greater part of the organ. Anovular follicular rings are present. Only a few ingrowths from the germinal epithelium are evident. The stromal elements are broken up by the follicles and show large blood vessels and a few zona pellucida remnants. An encysted portion of the oviduct is incorporated in the hilum.

Female 4583 was killed 164 days after exposure. The ovary is found to be anovular, and corpora luteal areas are present. Vacuolated cells form areas in the stroma which are alveolar in appearance, irregular in shape, and separated by fibrous trabeculae. Follicular rings are present around the periphery but the cell nests are not distinct from the stromal elements which are pushed in among them. An encysted portion of the oviduct is seen in the hilum of the gland.

Female 4585 was killed 176 days after exposure to the rays. The ovary is afollicular. A large cyst in the hilum has forced the ovarian

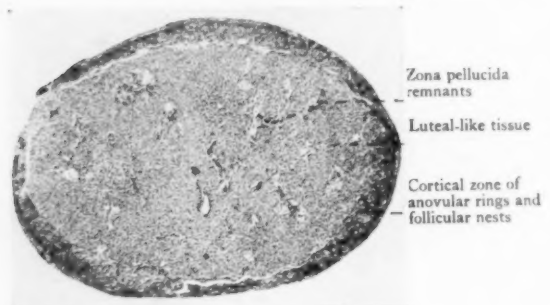



FIG. 25*b*. A whole section of the same ovary showing the general appearance of the cortical and medullary portions of the gland (×56).

elements up against one end of the antrum. Corpus luteal areas are found spreading between the common stroma, which is luteal-like and alveolar in arrangement. A very thin tunica albuginea extends around the periphery. Many anovular follicle rings are present but the definite cell nests are few and merge into the stromal elements.

Females 5095, 5138, 5277, 5640 and 5801 were killed 202 days after exposure.

Ovary 5095, 353 days old, shows follicular and stromal structures similar to a normal gland of this age, and is apparently unaffected by the irradiation. No corpora lutea are present.

Ovary 5138, 351 days old, shows no normal follicles but has a corpus luteum still persisting. The tunica albuginea is dense, forming a peripheral zone in which only a few follicular rings

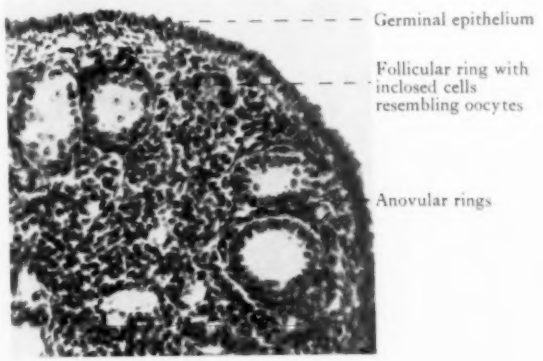



FIG. 26. A peripheral portion of a section from ovary 5801, 311 days old, 202 days after exposure to 54 r. The typical anovular rings are present. Epithelial rings with cells inclosed, which resemble somewhat the cell nests in young ovaries, are also prominent. The inclosed cells are apparently transitional stages between follicular cells and oocytes (×360).

are seen, while follicular nests are quite numerous. The stroma is grouped in alveolar areas and has a luteal appearance.

Ovary 5277, 343 days old, contains a large cyst which has forced the ovarian tissue over to one side of its antrum. A thick zone of epithelial rings is present on the periphery of the ovary on the side away from the cyst. Many follicular cell nests are mixed among these rings. One apparently normal follicle in secondary stage of growth is shown. Zona pellucida remnants, empty antra and large blood vessels are mixed through the medulla.

Ovary 5640, 323 days old, shows structures

characteristic of a much older gland. A few normal follicles are present around which many anovular rings are prominent, while the whole gland is very densely fibrous.

Ovary 5801, 311 days old, is greatly reduced in size and follicular rings are numerous both around the periphery and deep in the gland. This is the only evidence of normal follicles. Corpora lutea are absent. The medulla is rich in blood vessels and contains many zona pellucida remnants with no evidence of the luteal-like structures which have been common to the preceding tissues. In a number of the follicular ring structures, cells are found which greatly resemble the egg nests in embryonic tissues. These central cells are shown (Fig. 26) breaking away from the peripheral ring and changing form and size. Their nuclei have become promi-

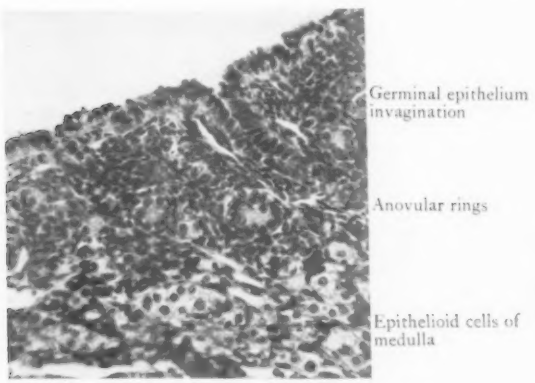



Fig. 27*a*. Peripheral portion of a section from ovary 6352, 309 days old, which shows the germinal epithelium invagination and anovular ring structures of the cortical zone (×360).

nently placed but not pycnotic, and the cytoplasm stains much lighter than in the ordinary ring epithelium.

Ovary 6340, 310 days of age, contains a few normal follicles in advanced stages of development. The remainder of the gland is similar in structure to that shown in Figure 28, fibrous tissue separating the alveolar structures into irregular shaped areas.

Ovary 6352, 309 days old, shows four follicles in advanced stages of growth and a fresh corpus luteum. The germinal epithelium is invaginated in part, and the tunica albuginea contains numerous follicular rings (Fig. 27*a*). Epithelial rings and cell nests are seen around the periphery in close relationship with each other. The migration of cells from these nests and their

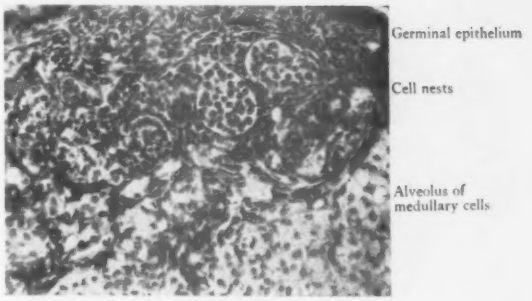



Fig. 27*b*. Another section from the same ovary, which shows follicular cell nests and a small portion of the alveolar structure of the medulla. Migration of cells from one of these nests into the fibrous tissue of the tunica albuginea is apparent (×360).

merging with the fibrous tissue elements is clearly seen (Fig. 27*b*). The medullary tissue is grouped in alveolar areas or broken up by the follicles and zona pellucida remnants.

Female 5855 was killed 230 days after exposure to roentgen rays. The ovary is anovular and afollicular. The tunica albuginea is very thin and germinal epithelium invaginations are not present. Within the tunica albuginea the whole organ is strikingly uniform in structure, with alveolar areas separated by fibrous trabeculae and arranged in groups or cords. This medullary tissue is luteal-like in appearance, some areas resembling corpora lutea but with no demarcation between them and the less luteal-like areas. Figure 28 shows the arrangement of the structures in the cortical region and is representative of the structure found throughout the whole gland.

Fig. 28. A peripheral portion of a section from ovary 5855, 336 days of age, 230 days after exposure to 54 r. The whole cortical zone contains large epithelioid cells in alveolar arrangement. The medulla is uniformly luteal-like in character (3×60).

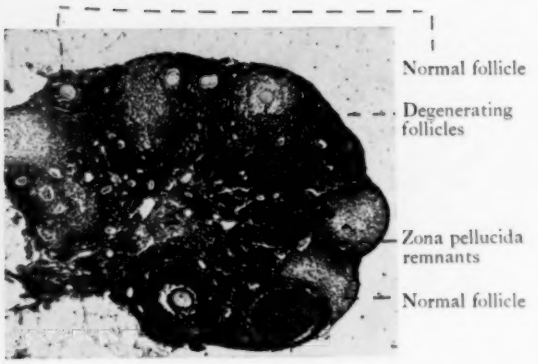



Fig. 29. A section from ovary 6159, 272 days old, two days after an irradiation of 150 r, showing absence of primary follicles, many zona pellucida remnants, and marked degeneration of older follicular types with normal follicles widely separated (×52).

A dose of 150 r was administered to 6 animals under the same conditions employed in irradiation of the 27 and 54 r groups (Table v), except for the method of holding the animals, as already given.

Ovary 6159, 272 days old, killed two days after the irradiation, shows no evidence of primary follicles. Many anovular rings are seen in the tunica albuginea and a marked degeneration of follicles in the older stages of development is evident. Normal secondary and tertiary follicles are present but are widely separated by the degeneration remnants. Figure 29 shows a section from this gland.

Ovary 6927, 197 days old, killed four days after irradiation, contains no normal primary follicles. Follicular rings are numerous but the degeneration of older types of follicles is not so marked as in the preceding gland.

Ovary 6968, 202 days old, killed twelve days after irradiation, contains no normal primary follicles. The gland shows signs of having recently ovulated, and there is marked hemorrhage among the young corpora lutea. Follicular degeneration among the older types is not atypical for the age.

Ovary 6803, 230 days old, killed twenty-one days after irradiation, contains no normal primary follicles. Only a few normal follicles of older types are present, the gland being mainly composed of degenerative remnants. The zona pellucida clumps and anovular rings are very prominent. Figure 30 shows a section from this gland.

The two ovaries from animals exposed to 150 r and killed forty-three days after the irradiation, show a total destruction of all follicular structure.

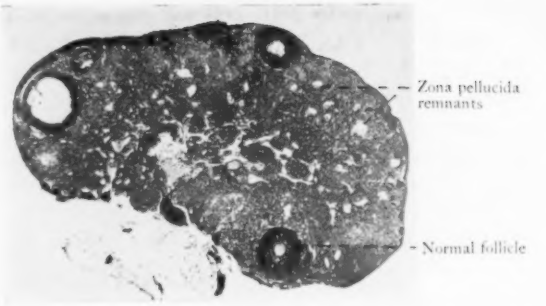



Fig. 30. A section from ovary 6803, 230 days old, 21 days after an irradiation of 150 r. Primary follicles are lacking. Zona pellucida clumps and remnants of older follicular degeneration make up the major portion of the gland. A few normal secondary follicles are present but are widely separated (×54).

Ovary 6674, 274 days old, contains no follicles. A thin peripheral zone shows numerous anovular rings among fibrous elements, while the interior of the gland is completely filled with an epithelioid cellular structure, with blood vessels and fragments of corpora lutea spread throughout. Figure 31 shows a whole section, typical in structure for the entire gland.

Ovary 7149, 215 days of age, exposed to the same dose and killed the same length of time after irradiation as 6674 (43 days), shows structures similar to that ovary. Figures 32*a* and 32*b* present sections of this gland.

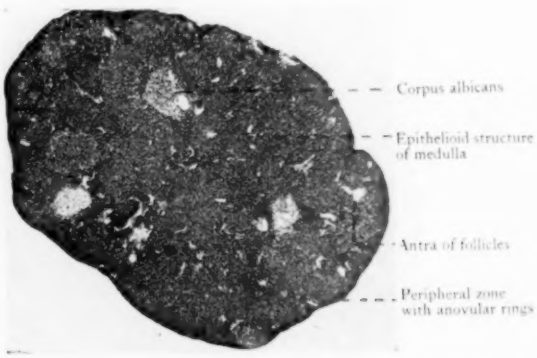



Fig. 31. A section from ovary 6674, 274 days old, 43 days after exposure to 150 r. The total destruction of follicles is evident. The medulla is filled with a common epithelioid cellular structure, with a fibrous peripheral zone containing many anovular rings. This is shown in higher magnification in other figures (×54).

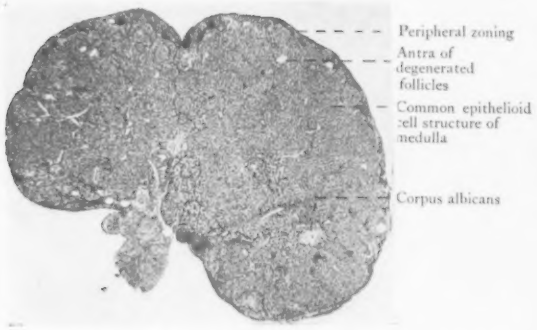



Fig. 32*a*. A whole section from ovary 7149, 215 days old, 43 days after exposure to 150 r, which shows the general destruction of all follicles and the formation of epithelioid cell structure common for the entire medulla. The peripheral zone of fibrous tissue with anovular rings is also seen (×49).

*Animals Exposed to 300 r.* Six animals which were exposed to 300 r (Table v) under conditions similar to those employed in the 150 r group were killed at post-irradiation intervals of two, four, twelve, twenty-one and forty-three days. The structures found in their ovaries are indistinguishable from those described in the preceding section. Primary follicles are absent in all. Total degeneration of all follicles is effected by the forty-third day, with replacement by epithelioid cells which make up the major part of the gland.

*Animals Exposed to 500 r.* Six animals were exposed to 500 r under these same conditions (Table v) and killed after the same intervals.

Ovary 4035, 426 days old, two days after irradiation, and ovary 4459, 383 days old, four days after irradiation, have no primary follicles but are otherwise like normal glands of the same ages.

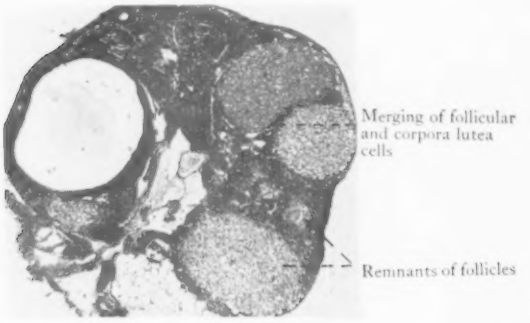



Fig. 33*a*. A whole section from ovary 5338, 335 days old, killed 21 days after dosage of 500 r. The areas of follicular degeneration are seen, with fibrous cells separating them only in part from the adjacent corpus luteum and other interfollicular elements (×54).

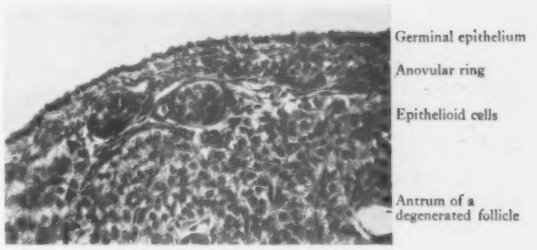



Fig. 32*b*. A higher magnification from a peripheral portion of the same section (×360).

Ovary 5355, 324 days old, twelve days after irradiation, contains no primary follicles, and follicles of older types are few in number. A great deal of follicular degeneration is present.

Ovary 5338, 335 days old, killed twenty-one days after irradiation, contains only a few normal follicles, these being in advanced stages of development. The follicular degeneration areas are large and cells are observed to break through the fibrous trabeculae which separate the corpora lutea from interfollicular elements. Figures 33*a* and 33*b* show two views of a section of this gland.

Ovaries from females 5069, 373 days old, and 6289, 305 days old, killed forty-three days after irradiation, show total destruction of follicular structures. The arrangement of the remaining structures is like that observed at this post-irradiation period after doses of 150 and 300 r. Figures 34*a* and 34*b* give two views of a section from ovary 5069, showing the structure typical for both of these glands.

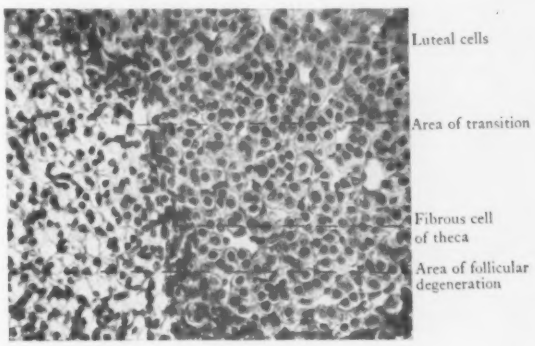



Fig. 33*b*. A higher magnification of a portion of the same section to show the intermingling of these cell structures (×360).

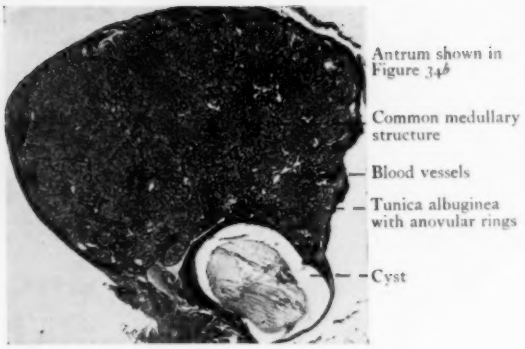



Fig. 34*a*. A whole section from ovary 5069, 373 days old, 43 days after exposure to 500 r, which shows the absence of follicular structure typical for the entire gland. The fibrous tunica albuginea with anovular rings is seen as a darkly staining zone around the periphery. A cyst, which has been described as occurring in about 33 per cent of the ovaries studied, is present at the hilum, while follicular antra are seen surrounded by epithelioid cells of the medulla (×44).

*Animals Exposed to 1800 r.* Ten animals were exposed to an irradiation of 1800 r (Table v). This dosage was found to cause the death of the animals usually during the fourth day. One animal within the group lived until the end of the fifth day.

Female 7274, 146 days old, was killed one day after irradiation. The ovary shows a marked hyperemia with blood vessels engorged and prominent in both medulla and cortex. The majority of the oocytes in primary follicles show pycnotic nuclei and fragmentation of cytoplasm. Many of the older follicles are in stages of degeneration. The zona pellucida is prominent and cytoplasm of the oocyte is clumped in these younger follicles, while many blood elements are seen to migrate into the stratum granulosum, and in most cases into the

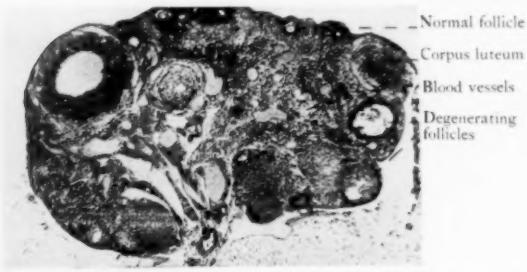



Fig. 35. A section from ovary 7274, 146 days old, one day after exposure to 1800 r. The whole gland is hyperemic and shows marked degeneration of follicles (×37).

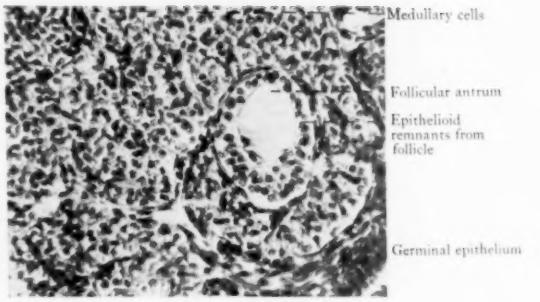



Fig. 34*b*. A higher magnification of a persisting follicular antrum in the same section. The epithelioid cells surrounding this antrum are common for the entire medullary region (×360).

antra of the larger follicles. Figure 35 shows a section of this gland.

The ovary of female 6695, 271 days old, killed three days after irradiation, shows the same marked hyperemia as the one just described. Primary follicles are lacking. Only a very few of older types could be called normal. The rest are markedly in various stages of degeneration. The corpora lutea are apparently normal.

The remaining 8 ovaries show essentially the same structure. No normal follicles are present but degenerating follicles of the older types are numerous. The corpora lutea are observed to be normal. A marked hyperemia around these structures, as well as around the degenerating follicles, is very prominent. Figure 36 shows a section from ovary 6917 which is characteristic for all of the group.

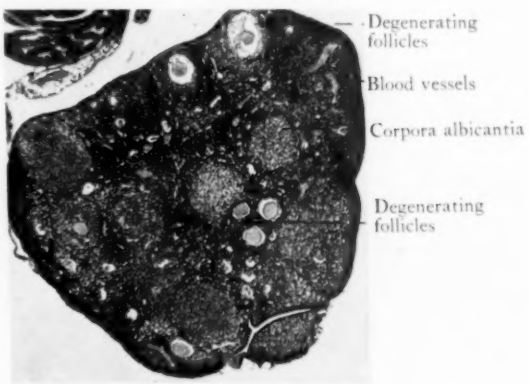



Fig. 36. A section from ovary 6917, 219 days old, four days after exposure to 1800 r. The follicles are all in various stages of degeneration, the gland showing a marked hyperemia. This section is characteristic for all of the ovaries of this post-irradiation interval (×54).

*Animals Exposed to 300 r, Quality A.* The structural changes among ovaries so far described have been produced by irradiation of quality "B." In addition, 11 young animals (Table v) were exposed to 300 r of quality "A." Six of these were killed 228 days after the irradiation; the remaining 5, twenty-six days later. The pictures of destructive changes produced by this dosage are interesting in relation to those produced by 54 r of quality "B" at a post-irradiation interval of forty-three days, as already described.

The dosage of 300 r to which these animals were exposed was administered in five doses, one-fifth of the total dosage being given on each of five consecutive days. The post-irradiation interval was computed from the date of the first exposure.

Ovary 1347, 388 days old, 228 days after irradiation, is lacking in normal follicular structures. A large cyst has crowded the ovarian tissues into a thin band which extends part way around the periphery. This band of ovary is filled with anovular rings similar to those previously pictured, but no invaginations of the germinal epithelium are present. The other constituents of the gland are small areas of fatty degeneration and epithelioid cells, with dense patches of stroma fibers in a few regions.

Ovary 1550, 355 days old, 228 days after irradiation, contains no normal follicular structures. A large part of the gland is composed of vacuolated luteal-like cells with areas of darkly staining epithelioid cells scattered through these structures. A great many anovular rings are present around a portion of the periphery of the gland, with small areas of fatty degeneration in the medulla near them. The germinal epithelium does not show invaginations. Figure 37 is a section of this gland.

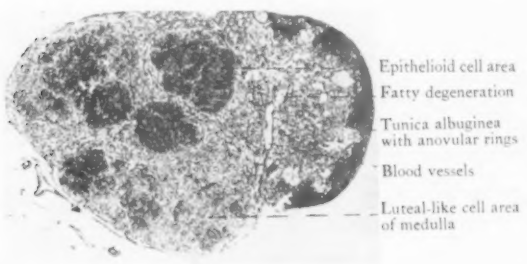



Fig. 37. A whole section from ovary 1550, 355 days old, 228 days after exposure to 300 r. The general luteal-cell character of the medulla is evident, with areas of fatty degeneration and epithelioid cell structure. A portion of the cortical zone with anovular rings is shown (×44).

Ovary 1553, of the same age and post-irradiation interval as ovary 1550, is afollicular and is composed of the same type of luteal-like and epithelioid cells. The darkly stained epithelioid areas are irregular in arrangement. In many of them, the cells appear as cords or tubules with, usually, a small-sized antrum in the center of the area. They display numerous mitotic figures. The gland is richly supplied with blood elements, many vessels lying in the fibrous trabeculae which are found bordering the cellular areas.

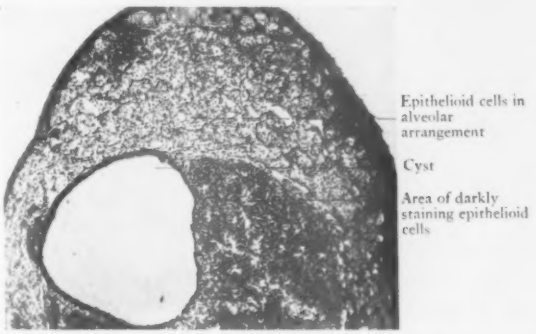



Fig. 38. A portion of a section from ovary 1576, 346 days old, 228 days after exposure to 300 r, showing both types of epithelioid cell structure, and alveolar arrangement of the lighter staining type (×145).

Ovary 1576, 346 days old, 228 days after irradiation, contains structures similar to those described for 1553. The presence of cysts plays a conspicuous part in the structural arrangement. Darkly and lightly stained epithelioid cell areas are found in alveolar or cord arrangement and are richly vascular. The cortical zone contains many anovular rings, while the germinal epithelium is not seen to invaginate. Figure 38 shows these structures in one section of the gland.

Ovary 1578, of the same age and post-irradiation interval as ovary 1576, contains a large cyst which has crowded the ovarian elements into a crescent-shaped mass. The structure of the gland is essentially the same as that of the preceding in that it has the alveolar arrangement of light-staining epithelioid cells, but epithelial cords are lacking.

Ovary 1807, 311 days old, 228 days after irradiation, is afollicular and contains epitheli-

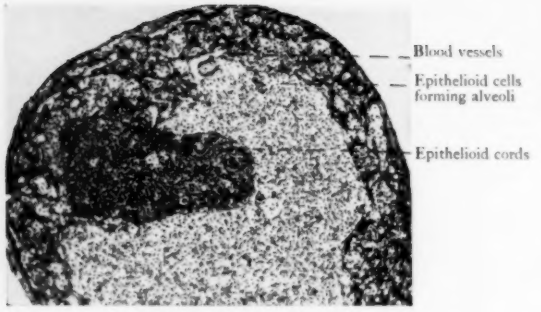



Fig. 39*a*. A portion of a section from ovary 1807, 311 days old, 228 days after irradiation, which shows a general picture of the epithelioid cell arrangement and the structures found. The darkly stained areas show many mitotic figures and cord-like arrangement. These areas do not extend out to the germinal epithelium. The lighter staining cells form into alveoli or are grouped into irregularly shaped areas (×110).

oid structures similar to those already described. Figures 39*a* and 39*b* show portions from two sections of this gland with typical arrangement of cell structures.

Ovary 1349, 414 days old, 254 days after irradiation, shows much the same structure as that described for 1807, except that it has persisting corpora lutea.

Ovary 1806, 337 days old, after the same post-irradiation interval, is composed almost entirely of luteal cells. A zone around the periphery shows a number of alveoli formed by epithelioid cells, and a number of cords containing these same elements. The gland is very vascular and resembles somewhat the ovaries exposed to 150 r and killed after forty-three days.

Ovaries 1892, 1894 and 1895, 327 days old, 254 days after irradiation, show the same structure. They resemble ovary 1806 in that their medulla is made up principally of luteal cells, but the peripheral zone of epithelioid cords is much thicker and more marked.

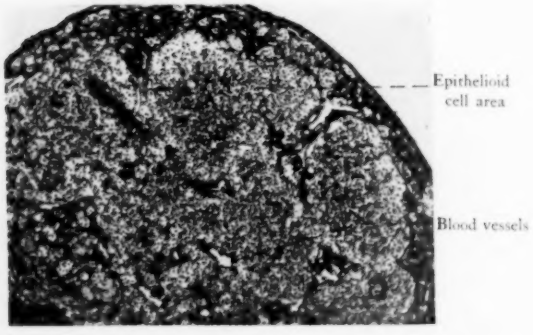



Fig. 39*b*. Another section from the same ovary showing the areas of lighter staining epithelioid cells (×132).

## DISCUSSION

Up to a few years ago, the fundamental factor of dosage was stated as a practically unknown quantity and quality in experiments which used roentgen rays. The results obtained were valuable in that they pointed out certain biological properties possessed by this type of radiation, but comparison between experiments from different sources was impossible except in formulation of general conclusions such as the production of death among small mammals, and destruction of skin and skin elements as a result of "large" doses administered over an extended period of time, etc.

Due to the united efforts of clinicians and physicists, the standardization of a unit for roentgen dosage has recently been effected and experimenters are now able to compare their results with a much greater degree of accuracy than was hitherto possible. The importance of such a unit is clearly seen if a correlation of results is to be attempted.

The unit employed in this study is identical with the International r and forms a definite physical basis for the comparison of results obtained in different laboratories. Under similarly produced conditions, a duplication of the doses used is possible within a small percentage of error. This error is not necessarily greater than 5 per cent, the average percentage of variation in the output of a standard apparatus.

With the introduction of this definable r for quantity, uncertainty of dosage is not completely eliminated, since the quality and intensity of the radiation, as well as the depth of tissue penetrated, must be carefully considered. The reproducible values of these factors as used in this experiment have already been stated. Since the tissues which cover the dorsal surface of the mouse

ovaries is at most about 2 mm. in depth, the measurement of the mouse target distance is essentially the ovary target distance, the difference being immeasurable.

Much attention has been given to the material which was employed. In choosing to use a highly inbred strain of animals an attempt has been made to eliminate a variable factor which is very often disregarded or assumed to be unimportant. The resistance or sensitiveness of the tissues of different animals to an agent like the roentgen rays, which shows its effect only after a certain latent period, must be largely dependent on the general physiological reaction of the animals to such an agent. As was early shown by other authors cited, individuals from different species react differently to the same physical administration of roentgen rays. This same variation in reaction has been noticed between animals of the same species but of different ages and sexes, and also between various individuals of the same species, age and sex. No experiment has been made, to our knowledge, in which the organs of highly inbred mammals have been tested for structural changes produced by this type of physical agent; and all the other variable factors influencing the results, controlled by closely related animals.

By close examination of the ovaries from such an inbred stock of mice, an effort has been made to determine the smallest dose of roentgen rays which would produce a detectable change in the structure of a normal organ. The animals were divided into groups so that individuals of different ages were represented for each dosage. Larger groups of animals were exposed to 27 and 54 r, since 54 r had been observed by Schugt to be the sterility dose for white mice. The larger doses were administered in order to obtain data on the relation which different doses bear to the types of structural change produced; and to attempt to learn whether a "norm" exists for the ultimate destruction of the ovaries at all ages and for all doses.

The absence of any definite primary effect on the structures in ovaries exposed to 27 r makes it apparent that this dosage is too small to perceptibly damage any of the tissue elements. Atypical ovaries, structurally similar to ovaries of a much greater age, occur with some frequency after this dosage, but the cause is too uncertain to classify it finally as being due to radiation.

In the work of Schugt also, which is perhaps the nearest to being comparable, it would seem to us that the structure which he describes as occurring after a dosage of 27 r, can probably be explained by the age-picture of the ovaries, while direct roentgen effect is very improbable.

One day after exposure to 54 r, the present experiment reveals a distinct change in the nuclei of oocytes of nearly all the primary follicles. The marked pycnosis in these oocytes, which were observed in 6 animals of ages varying from 90 to 215 days, is quite significant and will serve as a clean-cut biological end-point for comparison of dosages between different species of mammals.

The detectable changes produced in ovaries of animals killed between one and 139 days after this same dosage, are not uniform, but distinct evidence of atypical arrangement and development of primary follicles is indicated. Many ovaries at ages of 86 to 185 days show no trace of normal primary follicles, a condition which is atypical for this age group, as is shown by comparison with control glands. The occurrence of many anovular rings and only a few normal primary follicles in many individuals where invaginating germinal epithelium is not present, also indicates an initial destruction of this type of follicular structure. Ovaries with apparently normal structure are found in each age group, so that no uniformity of effect can be claimed during this post-irradiation interval.

The group of animals killed 139 to 230 days after an exposure to 54 r, exhibit a definite picture of destructive effects. But here again there is a wide variation, since ovaries are observed which show complete destruction affecting all types of fol-

licles, while one individual ovary in the group shows no definite evidence of any effect.

The time interval which separates the appearance of the first definite change in a majority of primary follicles and the appearance of total destruction of all follicular elements, shows that a dosage of 54 r is sufficient to produce destruction which after 139 days is marked. Total destruction is probably initiated by the disintegration of the destroyed primary follicles. The persistent appearance of occasional normal follicles in these degenerating glands makes the assertion that they are sterile questionable. The structural picture of some of these glands indicates the continuance of the cytogenetic function, and by actual breeding tests, this is seen to be true. While the presence of a structurally normal follicle in an otherwise completely destroyed gland, as seen after the longer post-irradiation intervals, does not mean that this follicle is capable of development and subsequent fertilization, nevertheless the possibility is not eliminated and true structural "sterility" has not been obtained.

The observations of Regaud and Lacassagne, who found degeneration among the ova of primary follicles in rabbit ovaries from fifteen hours to four days after irradiation, are similar to the results found for the 54 r dosage on these mice. Their assumption, however, that follicles which remain at the end of the first week after irradiation are unaffected is not borne out by the present observations.

Schugt obtained a much greater degenerative effect among his ovaries at six weeks after a dose of 54 r than was uniformly observed in these ovaries after the same post-irradiation interval. Similar degenerative pictures were observed in a few ovaries between 57 and 139 days following this irradiation, but these were not uniform until after 139 days.

The susceptibility of primary follicles, as reported by many other investigators, is borne out by these observations. The definite destruction of the ova one day after a dose as small as 54 r, and their total disappearance two days after doses of 150 to 500 r, makes them a good point of attack for a biological check on dosage effect. As is suggested by structures resembling oocytes which arise secondarily from the follicular rings, the apparently normal primary follicles occurring after longer post-irradiation intervals in the 54 r group, may for a time be supplemented by follicles of this regenerative type. These undergo disintegration and initiate further degeneration of the other follicular elements in the gland.

After 150 to 500 r, the general destruction of the whole follicular system follows more rapidly on the initial change, until at forty-three days replacement structures fill up the gland. It is suggested that these have their origin from cells of the strata granulosa of the follicles, with additional origins, in many instances, from corpora lutea and theca cells.

Many of the figures presented show transitional stages between the normal follicle cells and the epithelioid cells which constitute the major part of the afollicular gland. The intermixing of the luteal cells and follicular cell areas, with transitions between these elements, leads to the assumption that the common medullary structure seen in such glands arises from these sources. The epithelioid and luteal-like substance of these glands is similar to the "puberty gland" of Steinach and Holzknecht, and the "interstitial" tissue described by other investigators.

The replacement of normal elements of the organ by fibrous tissue, reported by other authors to be the ultimate picture of roentgen-ray destruction, is not observed in these ovaries under the present experimental conditions. Reduction in size of the ovaries is not seen except where corpora lutea are uniformly absent. The presence or absence of these bodies and the presence or absence of cysts make direct comparisons of size of practically no value. In an earlier experiment, in which mice two days old, of the same strain, were exposed to 300 r, total destruction of the gland was

observed, accompanied by marked reduction in size and the loss of all ovarian characteristics except, apparently, intact germinal epithelium. It is seen, then, that observations on reduction in size would not be significant unless the fibrous type of replacement was induced.

The ovaries described as having been exposed to 300 r of unfiltered radiation are reported because of their structural similarity to the ovaries exposed to the same dosage of filtered radiation administered at a different intensity. The difference in post-irradiation intervals between these two groups shows that the epithelioid structures persist over a long period of time and that the cord formations which grow in from the periphery are either of anovular ring epithelium origin or arise from the disintegration of the strata granulosa in older follicular types. The absence of germinal epithelium invaginations makes their origin from that source highly improbable. Since these cord-like structures resemble the "proliferation cords" considered by Parkes, and later by Brambell, Parkes and Fielding to be due to "continued proliferation of the germinal epithelium and in part to the mitoses of their cells . . . ." their origin from anovular ring epithelium would be essentially the same thing, except for the indirectness of the process.

## SUMMARY

The ovaries of 295 mice of a highly inbred strain were studied histologically. One hundred of these ovaries were from control mice of ages from 49 to 537 days; the remaining 195 were from closely related animals which had been exposed to various doses of roentgen rays.

Pedigree charts show the ancestry of each mouse in the experiment, tracing it back to the original pair of animals. The experimental animals used were taken from the eleventh to the nineteenth generations as shown on these charts. The roentgen dosage was computed in reproducible standard units and was uniformly and accurately administered.

Ovaries from the irradiated animals were removed after intervals of from one to 254 days following exposure. The tissues were fixed immediately in Carnoy's fluid, and later cut in serial sections 8$\mu$ in thickness and stained with hematoxylin and Congo-red.

Descriptions are given of the control ovaries insofar as is necessary for comparison with those which were irradiated. Camera lucida drawings of the various stages in one type of normally occurring follicular degeneration are shown, while other structures are shown by photomicrographs taken at magnifications of from 44 to 1800 diameters.

Pertinent detail on every animal, both experimental and control, is given in chart form. The atypical structures of irradiated ovaries are fully described, and the descriptions freely supplemented with photomicrographs.

From the findings, the following conclusions are drawn:

## CONCLUSIONS

1. The structural characteristics of the control ovaries do not serve as an accurate index of their age.

2. With very few exceptions, ovarian structures are comparable within the age groups, 49 to 150 days, 150 to 300 days, and 300 to 537 days, with usually an indication as to relative position in the particular group.

3. Follicular degeneration of the type which leaves zona pellucida remnants is no index of roentgen-ray destruction, since the occurrence of these structures is found to be extremely variable among control ovaries.

4. The variation in size of the control ovaries is too great to make this a factor for comparison with irradiated glands.

5. A dosage of 27 r is not sufficient to produce detectable changes under the conditions of the experiment.

6. A dosage of 54 r is sufficient to produce detectable changes in the structure of primary follicles in ovaries between 90 and

215 days of age. These initial changes are evident one day after irradiation.

7. Further definite changes for this dosage are irregular in occurrence up to the one hundred and thirty-ninth day after irradiation, when various degrees of destruction are invariably present.

8. Structural "sterility" is not uniformly obtained with this dosage in the post-irradiation intervals studied.

9. Structural "sterility" is produced in ovaries exposed to 150 r or more, the primary follicles being absent after two days, and all follicular elements absent by the forty-third day after irradiation.

10. A dosage of 54 r is sufficient to produce replacement of normal follicular elements by a common epithelioid or luteal-like structure. The replacement is complete after doses of 150 r or greater in forty-three days after irradiation.

11. A dose of 300 r of both qualities and intensities used, produces similar destructive changes and the replacement structures are also similar.

12. A dosage of 1800 r is lethal for adult mice of this strain in four days after irradiation.

13. The ovaries from animals exposed to this massive dose show marked follicular degeneration after one day. After four days, all follicular structures are found to be degenerating.

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# CHOLECYSTOGRAPHIC DIAGNOSIS OF PAPILLOMAS OF THE GALL-BLADDER

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ALTHOUGH benign tumors of the gall-bladder are rated as rare by pathologists, the papillomas, which are the most common variety, are found fairly often. For example, at The Mayo Clinic during the last seventeen years papillomas were found in 8.5 per cent of more than 17,000 gall-bladders surgically removed. The polypoid masses are small, the diameter seldom exceeding 1 cm., and may be single or multiple. When multiple there are usually not more than two or three, and these are likely to be discrete, but exceptionally they are numerous and closely grouped. Papillomas are found more often in gall-bladders which are otherwise normal or present only faint microscopic signs of disease, but they occur also in association with chronic catarrhal cholecystitis and with cholelithiasis, especially with a single stone. Their clinical and pathologic significance has not been fully determined, but in many cases observed at the Clinic papillomas, even though small and not accompanied by definite cholecystitis, seemed to have a causative relation to the patient's symptoms, for cholecystectomy was followed promptly by relief. Although the potential malignancy of papillomas must be conceded, malignant degeneration is evidently rare, for only one instance has been noted among more than 1400 cases of papilloma seen at The Mayo Clinic.

In a paper read before the International Congress of Radiology at London in 1925, shortly after the advent of cholecystography, Carman asserted that it should be possible to show evidence of papillomas, if they are sufficiently large, in the cholecystogram. He did not live to see his prediction verified. At that time techniques and interpretation lacked an adequate background of experience, and it was safer to attribute all persistent shadow-defects in the cholecystogram to gallstones. Until recently I have assumed that roent-

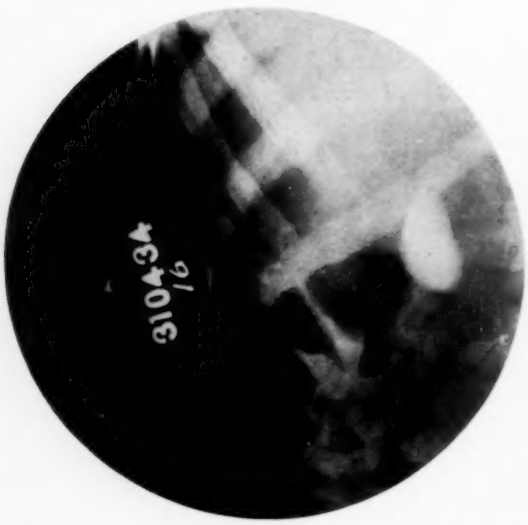


FIG. 1. Cholecystogram at sixteenth hour, before the administration of a fat meal. No defects are visible in the gall-bladder shadow (see Fig. 2).

FIG. 2. Cholecystogram after a fat meal. A round, clear defect is shown near the fundus. An adenomyoma was found at operation.

Fig. 3. Case 1. Cholecystogram at sixteenth hour. Dense shadow of gall-bladder. The indefinite small defects cannot be distinguished from those produced by gas in the small bowel (see Figs. 4 and 5).

Fig. 4. Case 1. Cholecystogram at twentieth hour. One definite defect is shown near the fundus, another near the outer margin, and several smaller scattered defects. A diagnosis of multiple papillomas was confirmed at operation.

genologic distinction between papillomas and stones with a low calcium content was still impracticable.

Several months ago, however, I observed a cholecystogram in which there was an unusually good shadow of the gall-bladder with a small, rounded transradiant area near the fundus. This area appeared only in the cholecystograms made at the twentieth hour. Reëxamination yielded an identical result and the transradiant area was in exactly the same relative position. A diagnosis of a normally functioning gall-bladder with a single stone was made. At operation the gall-bladder was removed and the pathologist reported chronic catarrhal cholecystitis with an adenomyoma 8 mm. in diameter. Stones were not present (Figs. 1 and 2).

This depiction of a soft-tissue tumor, although wrongly diagnosed, renewed my interest in the possibility of identifying papillomas. It seemed logical to conclude that papillomas, being fixed to the cystic wall, would preserve the same relative situation in all cholecystograms; that they would cast rounded defects in the shadow; that being small the defects would probably not be visible until the gall-bladder was partially emptied, and that, as the

Fig. 5. Case 1. Mucosal surface of gall-bladder. The papillomas correspond in situation to the defects seen in Figure 4.

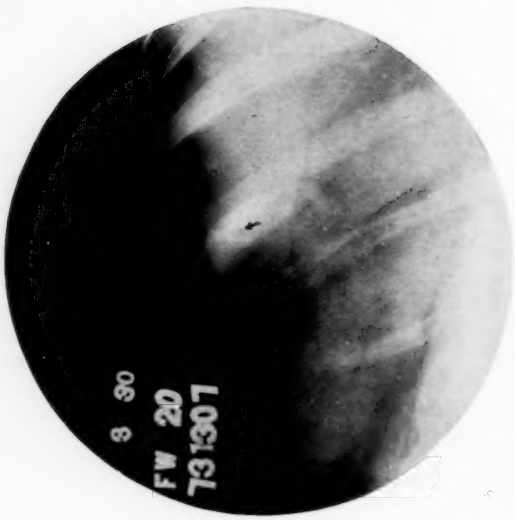


FIG. 6. Case II. Cholecystogram at twentieth hour. The defect is indicated by the arrow. A diagnosis of papilloma was confirmed at operation.

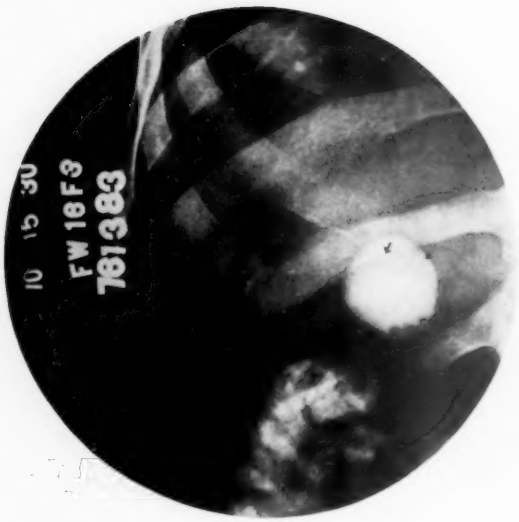


FIG. 7. Case III. Multiple, marginal, clear defects in a shadow which is otherwise of unusually good quality. A diagnosis of multiple papillomas was confirmed at operation (see Fig. 8).

mucosa was likely to be normal, the shadow of the viscus would be of good quality.

On that basis the diagnosis of papilloma has been ventured in about 20 cases. Operation was performed in only 4 cases, and the diagnosis was confirmed in each of the four. In each of them the papillomas were multiple, and in one instance numerous; the largest in each case was 5 mm., 6 mm., 10 mm., and 5 mm., respectively, in its greatest diameter (Figs. 3 to 10). The papillomas were associated with chronic catarrhal cholecystitis in 3 of the cases, but in the fourth the gall-bladder was otherwise normal. All four patients were reëxamined to confirm the presence, persistence and identical situation of the defects. All diagnoses were made by the oral method, and, as usual, without any knowledge of the clinical facts.

FIG. 8. Case III. Mucosal surface of gall-bladder. Multiple papillomas are shown, the largest of which is seen in profile.

From a review of the available cholecystograms of all our cases in which papillomas were found at operation, including those not diagnosed, the following characteristics may be summarized:

1. Without exception the shadow-defects produced by papillomas maintained the same situation on all films, even at reëxamination.

2. The defects were evenly rounded, and were usually less than 5 mm., never more than 1 cm., in diameter.

3. No defect was seated immediately at the fundic pole.

4. Often the defects were marginal and

Fig. 9. Case IV. Cholecystogram taken at the sixteenth hour. Two small clear defects are shown, the larger at the internal border (see Fig. 10).

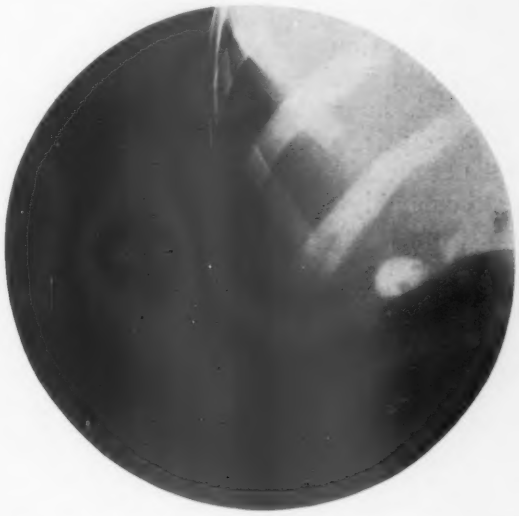

Fig. 10. Case IV. At the twentieth hour defects are constant in situation. Diagnosis of multiple papillomas. At operation three papillomas were found, the largest having a diameter of 5 mm.

then were especially suggestive of papillomas.

5. In most instances only one or two defects were visible, but occasionally there were three or more.

6. When multiple the defects were discrete, never closely aggregated.

7. Frequently the defects were of unusual clarity, greater than that produced by stones, however light.

8. As a rule the defects were most plainly visible at the twentieth hour and in many cases were seen only at this time.

9. Aside from the small defects representing the papillomas, the shadow of the gall-bladder was of excellent density and frequently better than the average. This is in consonance with the work of Caylor and Bollman, who found that gall-bladders with papillomas and the associated hypertrophic rugae produced the greatest concentration of bile.

With respect to the differential diagnosis, it is freely to be admitted that most of the cholecystographic manifestations of papillomas may at times be imitated by those of gallstones. However, gallstones almost invariably change in situation on successive films or at reëxamination, are often observed immediately at the pole of the fundus, tend to bunch closely together as the gall-bladder contracts, are likely to have facets, angular borders and a peripheral dense deposit of calcium, and are not often clearly transradiant. Radiolucent areas produced by collections of gas in the small bowel may resemble those caused by papillomas, but the former tend to shift about or to disappear. Many varieties of neoplasms may take on a papillary form and resemble true papillomas so closely that roentgenologic distinction is impossible. As papillomas have a far higher incidence, however, they should be given diagnostic preference.

Recently I have emphasized the necessity of employing as a routine a rational and painstaking cholecystographic technique. This is especially necessary for the demonstration of papillomas. To obtain a satisfactory shadow of the gall-bladder, the dye should be given in palatable and absorbable form, and administered immediately after a full meal from which fats are excluded. Approximately two hours before the final (twentieth hour) set of cholecystograms is made, the patient should be

required to take a meal which includes a high proportion of cream, butter and other fats. If the final set is deferred beyond the twentieth hour the gall-bladder is likely to be emptied completely and papillomas will not be visualized. The patient must be thoroughly immobilized during roentgenography, otherwise the small rarefactions will be obliterated. Reëxamination is almost indispensable to establish the actuality and unchanging position of the defects.

Since the clinical significance of papillomas is not settled, the value of their roentgenologic identification might be questioned, but their distinction from gallstones, when feasible, may at least have weight in determining the line of treatment. Further, although only a few cases are presented here and more extended investigation will be required before definite conclusions can be drawn, the results thus far obtained have a broad bearing on the diagnosis of tumors of the gall-bladder. In the light of subsequent experience, the adenomyoma which was mistaken for a stone has roentgenologic features which should identify it as a tumor. If, then, papillomas can sometimes be diagnosed as such and other tumors can be recognized, it is not extravagant to hope that eventually cholecystography will reveal carcinomas of the gall-bladder in the early stage, when surgical intervention may prove effective. That would be the crowning achievement of a method to which we already owe so much.

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Vol. XXV, No. 1

# PEPTIC ULCER

## THE DIAGNOSTIC VALUE OF THE ROENTGEN RAY BEFORE AND AFTER TREATMENT*

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ROENTGENOLOGY has made important contributions to the knowledge of chronic peptic ulcer of the stomach and duodenum, as is demonstrated by the reliance which physicians place upon the roentgen findings. Such confidence, however, has not been devoid of untoward results. It has fostered a neglect of the older methods of diagnosis, and a tendency to accept as facts certain assumptions which have not as yet been proved. The data presented in this paper were collected for the purpose of gaining an idea as to how far this faith in the roentgen method of examination is justified.†

Intelligent treatment of a patient suspected of having a chronic peptic ulcer requires answers to the following questions:

1. Does an ulcer actually exist?
2. Is hyperchlorhydria present?
3. Does a continuous secretion of gastric juice occur?
4. Is hypersecretion present?
5. Is obstruction present? If present, is it due to
   a. Spasm?
   b. Inflammatory swelling?
   c. Scar tissue contraction?
6. Is perigastritis or periduodenitis present?
7. Is there an hour-glass constriction?
8. Has the disease been cured?

Some of these questions may easily be disposed of. It is obviously impossible to determine roentgenographically the degree of acidity and rate of secretion of the gastric juice. It is possible that roentgen studies may reveal a condition of hypersection, but we have few data as yet on this point. Such study, on the other hand, is far superior to all other methods in showing the presence of an hour-glass constriction. Questions 2, 3, 4 and 7 need no further comment.

### THE DIAGNOSIS OF ULCER

The accuracy of roentgen diagnosis is of supreme importance because of the general reliance clinicians now place upon it. In another paper[1] we reported that an ulcer of the stomach or duodenum was demonstrated by the roentgen ray in 474 out of 510 cases, or 93 per cent of patients in whom the diagnosis of ulcer was definitely established. A higher degree of accuracy could be shown if only the recent cases had been studied, for many of the mistakes were made in the early days when the technique of roentgen diagnosis was less satisfactory. Thirty-six cases (7 per cent) failed to show an ulcer, though it was found at operation or post-mortem examination in 18, and seemed certain in the rest because of the definite history, often with hemorrhage.

Since that paper was written we have collected 13 more cases showing definite ulcers by roentgen examination, which by previous examination had been reported as negative. One of these was a penetrating gastric ulcer, the rest were in the duodenum. The symptoms had been present from three months to thirteen years before the first examination, and 10 had been treated as cases of ulcer in spite of the lack of confirmatory roentgen evidence, with relief for considerable periods of

† Our observations have been derived entirely from the records of the Peter Bent Brigham Hospital, which is very fortunate in having for its roentgenologist, Dr. Merrill C. Sosman. We have the greatest regard for his ability and feel that his observations herein discussed are of the highest order. This should be kept in mind, as the value of the data depends upon the individual and not upon the machine. It should be added, however, that Dr. Sosman is not responsible for any of the conclusions which have been drawn.

* From the Medical and Roentgenological Departments of the Peter Bent Brigham Hospital, Boston. Read at the Radiological Conference (New England Roentgen Ray Society, New York Roentgen Society, Philadelphia Roentgen Ray Society, Radiologists of Washington, D.C., Radiologists of Baltimore, Md.), Boston, Mass., Jan. 24–25, 1930.

time. The disease must, therefore, have been present at that time, but for some reason the deformity was not observed.

Improvement in the roentgen diagnosis of ulcer is having far-reaching results in the whole problem of peptic ulcer. It has resulted in an earlier recognition of the disease. Treatment is instigated earlier and fewer patients develop severe degrees of obstruction and other complications. It has done much to clarify the uncertainty concerning the existence of the typical distress of ulcer. Cases with typical symptoms which were formerly given a functional diagnosis such as hyperacidity because roentgenography failed to demonstrate the ulcer, today are being diagnosed as ulcer because the roentgen ray is able to find a deformity. The ability of the roentgen ray to discover small lesions is forcing the profession to reevaluate the nature of the disease and our methods of treatment. The opportunity to follow the development of ulcers over a period of years has taught us that this disease may remain stationary. The presence of an ulcer is not necessarily as dangerous as was previously supposed. Undoubtedly, many patients who were treated throughout life for hyperacidity had ulcers which the roentgen ray did not discover. Hence, it is foolish to cause a patient to undergo a severe and time-consuming surgical or medical treatment simply because he or she has an ulcer.

Today, a definite diagnosis of ulcer by a good roentgenologist is very reliable. We have but rarely proved a positive report to be incorrect. Negative or questionable findings have not been so satisfactory. The errors are chiefly of omission rather than commission, but are astonishingly few when one considers the large number of cases in which negative reports have been correctly made.

The "secondary" signs of ulcer, hyperperistalsis and hypermotility, as measured by the number, strength and speed of the peristaltic waves and by the point which the barium column has reached at the end of six hours, receive less attention than formerly. Both vary so inconsistently in serial examinations on the same patient that no conclusions can be reached from them as to the presence or absence of ulcer. We have not included data on these findings in patients in whom an ulcer does not exist. The policy of the department of roentgenology in this hospital of refusing to diagnose an ulcer merely by the presence of these secondary factors seems sound. They should be reported, however, for if they are found without the deformity of ulcer they may be helpful in deciding upon the treatment of cases whose symptoms are definite.

## RETENTION

Retention, as shown by the presence of barium in the stomach six hours after ingestion, was present in 88 patients in a series of 196, or 44 per cent. The amount varied greatly. It was small (a trace to 20 per cent) in 50; moderate (20–50 per cent) in 22; and large (50–100 per cent) in 16. Retention was present in 50 per cent of the gastric ulcers and in 44 per cent of the duodenal ulcers.

Retention is nearly always the result of interference with the discharge of stomach contents through the pylorus, and is the resultant of two factors, the amount of obstruction and the quality of the gastric tonus and peristalsis. Thus a large retention may be present with only slight obstruction if peristalsis is weak, or there may be little or no retention in the presence of considerable obstruction if peristalsis is vigorous. Nervous factors (headache, nausea, or worry over the outcome of the roentgen examination) are not rarely the cause of large residues. Individuals in whom an otherwise unexplained retention is found should always be questioned as to these influences, and the findings should be incorporated in every report. Organic obstruction with ulcer is a potent argument for operative treatment, and it is very important for

the roentgenologist to distinguish it from a functional retention.

How accurately can this be done, and how closely may retention, as observed by roentgen examination, be expected to agree with that which is observed clinically? The roentgen ray reveals very clearly the amount of residue in the stomach at a particular time; how far are we justified in assuming that this is equivalent to the retention which the stomach habitually has? Only one roentgen study is usually done. Furthermore, the average barium meal is quite different from ordinary food. When freshly stirred, it is a heavy liquid which pours through a small opening more rapidly than food of a different consistency, and from an active stomach it may empty faster than an equivalent mass of food. When passage is delayed, particularly in atonic stomachs, the barium quickly settles out, forming a heavy mass which is not readily discharged, and may thus give an exaggerated idea of the amount of obstruction present.

In 174 of our cases it was possible to make a satisfactory comparison of the amount of retention observed clinically and roentgenographically. The clinical impression was based upon the frequency and severity of vomiting and upon the amount of gastric contents recovered from frequent aspirations. Most of the cases were those under a routine Sippy management, in which aspiration is an important factor. The two methods agreed in 116 cases, or 67 per cent. These cases fell almost entirely into two groups: (1) those with normal peristalsis, no six hour residue and no clinical retention, and (2) those with markedly increased or sluggish peristalsis, large residues and marked clinical retention. Disagreement occurred most frequently in the cases which fell between these two extremes, those with small or moderate clinical retention and 5 to 50 per cent residue. The two methods did not disagree in any one direction. Thus one patient might show a moderate retention by the roentgen ray and have a small retention of food; whereas another patient with a moderate retention by roentgen ray would show a large retention of food.

Variation in peristaltic activity must account for some of this disagreement. Patients with no six hour residues not infrequently showed considerable clinical retention when they were first started on the Sippy regime, but this disappeared in a few days or weeks. Evidently the first effect of treatment was to decrease irritability, thereby revealing an obstruction which had been compensated for by increased motor activity. Later, as the spasm, edema and inflammation disappeared, the retention also disappeared. Dr. Sosman has recently lent support to this theory by noting that peristalsis was less active in many patients after treatment had been started than it was before. Although the disagreement between the roentgen and clinical retention was not always enough to be of practical importance, there was a sufficiently large number of cases encountered in which the difference was striking enough to make it unwise to accept the roentgenologic evidence of retention without question. It has been our experience that in interpreting roentgen retention, the following rules can be followed: A small retention (a trace to 20 per cent) can be ignored, at least temporarily. A moderate retention (20–50 per cent) with normal or even hyperperistalsis should be investigated further before accepting one report as final proof. Thus if the roentgen finding were the only reason for undertaking surgery, it would be wiser to wait until the finding of a 40 per cent retention was confirmed. However, the presence of deep bisecting waves showing that the stomach was definitely hypertrophied is evidence that a real obstruction is present and the report may be accepted. The same rules apply to a large retention. The presence of deep, so-called "obstructive" peristalsis or a distended atonic stomach, is evidence for organic obstruction. A large retention without these findings may be functional.

It would be most helpful to be able to differentiate quickly between these causes of retention. Amyl nitrite is of only occasional help in proving pyloric spasm, and atropine and belladonna have been of no help. Their employment in gastrointestinal studies has been abandoned in favor of an ordinary re-examination, after a short period of medical treatment, combined with gastric lavage when there is marked retention. We have not found the roentgen ray dependable in detecting the difference between irreducible scar tissue and inflammatory swelling. In other words, where the question of medical or surgical treatment has to be decided upon because of retention, we have found it necessary to settle the matter by a therapeutic test of a good medical regime. If the retention does not disappear in a reasonable length of time, surgery is usually indicated.

### HEALING AND CURE

The ability of the roentgen examination to determine healing of an ulcer is important both clinically and scientifically. The patient and his physician wish to know whether treatment is producing, or has produced, the desired effect and they naturally use the roentgen ray to discover whether healing is taking place. The authors' experience, however, has made them feel that the roentgen ray is of questionable value in determining healing. Moreover, a study[1] of a group of patients with ulcer showed that, irrespective of what the roentgen examination may show, the disease of ulcer is a chronic one, that the methods of treatment are palliative and that the disease is rarely cured. These conclusions have been questioned largely on the basis of the roentgen evidence.

In considering the use of the roentgen ray as a means of following a patient with peptic ulcer, two factors must be kept in mind: the disease itself, on the one hand, and its local manifestation, or the ulcer, on the other. Thus the disappearance of a gastric niche gives ocular evidence of the subsidence of a lesion, but is no more evidence of cure of the primary disease than is the disappearance of petechial spots in a case of subacute bacterial endocarditis. Whatever interpretation is put upon the roentgen findings, therefore, cannot be used against the conclusions concerning the nature of the disease based upon the clinical course of the patient.

Although such use of the roentgen ray appears logical, its interpretations have bothered us. A gastric ulcer is reported as healed when the deformity or niche disappears. On the other hand, a duodenal ulcer is frequently reported as healed, though a deformity persists. In discussing this apparent incongruity with roentgenologists and clinicians, the only answer readily forthcoming is that the persistence of the duodenal deformity is due to scar tissue. No explanation is given as to why the cicatrization which may be more extensive in gastric ulcers disappears. If the persistence of the deformity is due to scar tissue, then its recognition is valueless as an aid to diagnosis. It is obviously absurd to make a diagnosis of an active duodenal ulcer by the finding of a deformity, give some form of treatment and on finding the same deformity at a later examination explain its persistence on the basis of scar tissue, and assert that the disease is cured.

As most of the current beliefs regarding the disease of ulcer based on roentgen reports were at variance with our experience, we attempted to find on what grounds the beliefs are based. The literature failed to help us and it would appear that many of the ideas have developed without very good reason for them. We have, therefore, studied a few cases for ourselves to determine whether it is possible to differentiate an active from a healed ulcer, and whether the roentgen ray supports or denies the idea that an ulcer of the duodenum is a chronic disease.

We have stated elsewhere[1] that 93 per cent in a series of 67 duodenal ulcer cases, treated by several forms of medical and surgical measures, continued to show

deformities. Since those data were collected, 73 more cases have been assembled, making a total of 140 cases. The deformity remained in 132, or 94.3 per cent. Those patients in whom the deformity disappeared had received medical treatment, 110 patients in all having taken medical treatment; 30 patients, also, had had a gastroenterostomy done and in none of these did the duodenal deformity disappear. The persistence of the deformity in such a high percentage of patients means that the disease is chronic as the clinical course suggests, or that the persisting deformities are occurring with a healed ulcer. If the latter is true, then it is necessary to be able to recognize qualities in the deformity of a healed ulcer distinct from those of an active ulcer. Otherwise it would be obviously impossible to distinguish roentgenographically between the two.

An ulcer that has healed may conceivably show: (1) no deformity; (2) a deformity due to scar tissue as opposed to spasm.

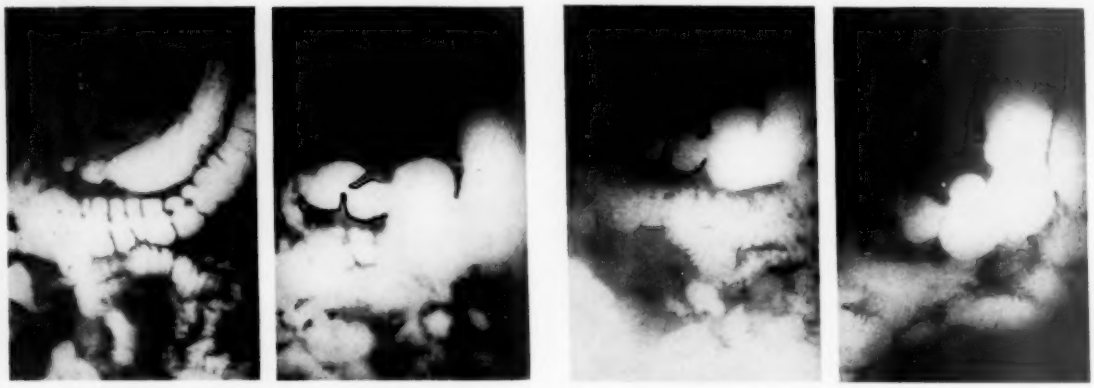
To distinguish such a deformity it must be characteristic and it must not change its appearance. With this in mind, we have studied those patients who have had two or more roentgen examinations.

The routine procedure for a roentgen examination of the gastrointestinal tract of patients at the Peter Bent Brigham Hospital is as follows: At 7 A.M., the patient takes 90 grams of barium sulphate in water, together with a light breakfast of cereal, toast and tea, or coffee. Six hours later, a roentgenoscopic examination is made, retention is noted, and then a second drink of barium is given. Roentgenoscopy is done in the upright, prone, supine and oblique positions. If a lesion is seen it is sketched and then three films are taken, with the patient in different positions. Two records are thus available for study: the freehand sketch of the lesions, and the films.

Let us consider, first, the significance of a disappearance of a deformity. Active ulcers in the duodenum can occur without producing a deformity, as is generally recognized by the willingness of roentgenologists to diagnose an ulcer on discovering a crater although the cap fills normally. Moreover, it is possible for a patient to have the symptoms of ulcer with a cap which fills normally and without any crater being demonstrated.

B. C. M., an engineer, aged twenty-eight, was first seen in November, 1926, having had symptoms of ulcer for six months. A roentgen examination was reported as follows: "The esophagus appeared normal. The stomach showed good tone, vigorous peristalsis, a smooth outline, and no residue. The duodenal cap was large and filled well. The ileum and cecum appeared normal. Twenty-four hour examination showed a spastic colon. Impression: Negative gastrointestinal series". On a bland diet and frequent feedings, his symptoms were controlled. In May, 1927, his symptoms returned and the second roentgen examination read: "Re-examination showed a normal stomach with no six-hour residue. The duodenal cap filled well but on palpation there was a constant fleck on the posterior wall (1 cm. beyond the pylorus), which was about 0.5 cm. in diameter, and which apparently represents the crater of a penetrating ulcer. The ileum and cecum were again normal. Impression: Duodenal ulcer." In January, 1928, the patient had another examination and this time showed both a crater and a deformed cap.

It is possible that a crater was missed at the first examination, but it is also possible that no crater was present. It is well to recall the gross appearance presented by an ulcer. On the outside of the duodenum is a stippled area with or without some puckering. If the duodenum is opened, the mucous membrane surrounding the crater may show some swelling, reddening and stippling. The idea that this reaction is secondary to the ulcer, as has been generally believed, we do not think is necessarily correct. The stippling may be as much a part of the disease as the crater and may occur without the presence of an ulcer. This can explain those cases having typical symptoms which fail to show an



A B C D

FIG. 1. The cap appeared irritable on two examinations, and filled normally on two others. The deformity in the first film was not constant. Symptoms were the same at all times.

ulcer at operation. It may explain some of the changes observed in deformities of the duodenum which will be mentioned later. This is probably the condition in those patients having symptoms of ulcer and showing an irritable cap at the time of the roentgen examination, but without a deformity characteristic of ulcer. The following case is an example of what is meant:

A. L., male, aged thirty-five, has been followed for four years, during which time he has been having characteristic symptoms. He has had four roentgen examinations (see Fig. 1). The first showed an irritable cap but no typical deformity. One and one-half years later, the cap filled well, and this was also true one year after the second examination. A fourth examination was done the following year, and showed again an irritable cap not unlike that seen at the first examination.

Clinically this patient has an ulcer and has had the same symptoms when the cap filled normally as when it was irritable. There have been other cases in the series in which a deformed cap has become normal, and returned later to its original deformity. In the face of such evidence, therefore, a well-filled cap does not necessarily mean that no ulcer is present.

As one studies the duodenal deformities, it is found they can be divided into eight different classes. These are shown in Figure 2. *a*. Shows a normal duodenal "cap" in the center of which is the crater of an ulcer. This may be found in any situation. It may be found only on palpation, when barium is expressed from the area. Puckered rugae may be visible about the crater or may be seen above. No spasm is apparent. *b*. Shows a mild indentation or spasm on both sides. *c*. Shows the familiar "clover leaf" deformity, and *d*, the "collar button" type. *e*. Shows an asymmetrical cap with a typical retraction of the superior border. *f*. Is essentially a "clover leaf" with a few more indentations toward the

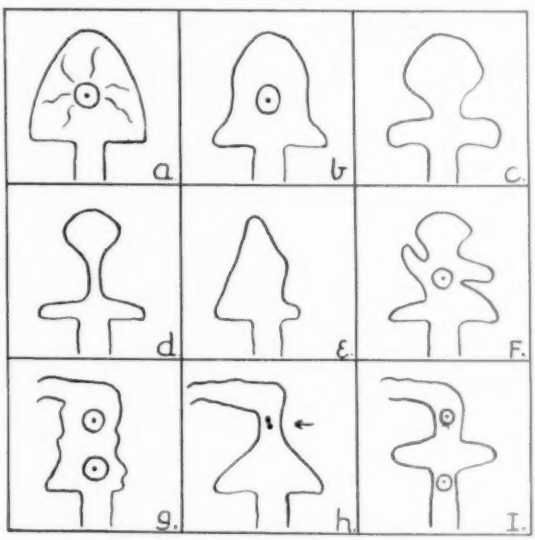



FIG. 2. Types of duodenal deformities produced by ulcer.

center. All these may be different stages of the same process, namely, a retraction of the cap toward a focus. Whenever the crater of an ulcer has been observed in these types, it has been represented in the sketches by circles. *g*. Shows a generalized narrowing of the "cap"; *h* is pyramidal in shape caused by an ulcer at the tip of the "cap" and *i* is the usual "maltese cross," probably due to two ulcers placed some distance apart.

these various deformities change. If any of them represent healed ulcers with scar tissue then those particular deformities should not change. We have 52 cases to date which have been studied over periods ranging from a few months to several years, and on which two or more observations have been made.

In making such a study great care is necessary to differentiate between a true and an apparent change. An apparent change may result from a total or partial obliteration of the deformity by the second, third or fourth portions of the duodenum passing behind the first (see Figs. 3 and 4). Another source of error arises in different degrees of filling of the

TABLE I

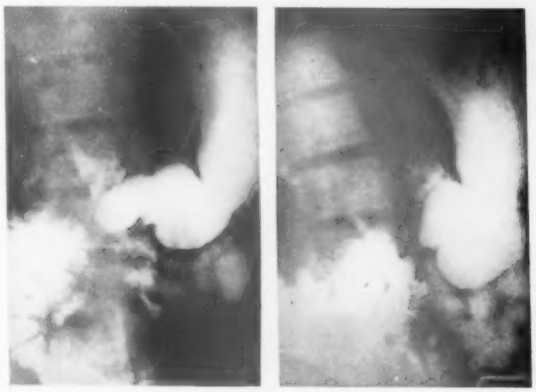
A COMPARISON OF THE TYPE OF DEFORMITY IN 142 CASES OF DUODENAL ULCER WITH THE DURATION OF SYMPTOMS

| Class of Deformity | No. Cases | Duration of Symptons | Average |
|---|---|---|---|
| Simple constriction (*b*) | 30 | 1 mo. to 15 yr. | 5½ yr. |
| Clover leaf; collar button (*c* and *d*) | 21 | 1 yr. to 30 yr. | 8½ yr. |
| Retraction of one side (*e*) | 39 | 2 wk. to 45 yr. | 8 yr. |
| General irregularity (*f*) | 27 | 1 mo. to 45 yr. | 6½ yr. |
| Generalized narrowing (*g*) | 14 | 6 mo. to 25 yr. | 9 yr. |
| Pyramid (*h*) | 5 | 2 mo. to 16 yr. | 6½ yr. |
| Maltese Cross (*i*) | 6 | 6 mo. to 25 yr. | 9 yr. |

If one is to recognize a healed ulcer from the appearance of the cap, one would expect that the age of the ulcer would be a factor. We therefore noted the length of time that the patient had had symptoms and recorded it in Table 1. It is seen from these results that any of these deformities may occur early in the disease and that as the years go by, there is no greater tendency for one type of deformity to predominate than another.

We investigated the incidence of tenderness in the different types of deformity on the assumption that it was evidence of an active ulcer, and found that there was no difference in the various forms. To our surprise, it proved of little value in the series of 174 cases studied. It was present before treatment in 39 cases, afterwards in 15. It was not related to the size, type, or location of the ulcer. Some patients retained the tenderness, others lost it, and others had it on the second examination but not on the first, and all without regard to their clinical progress.

The next factor to consider is whether



A B

FIG. 3. A good example of how an overlying third portion may be misleading. The first illustration shows a duodenal deformity and barium in the duodenojejunal junction. The second illustration shows the two overlapping. Both films were made at the same examination.

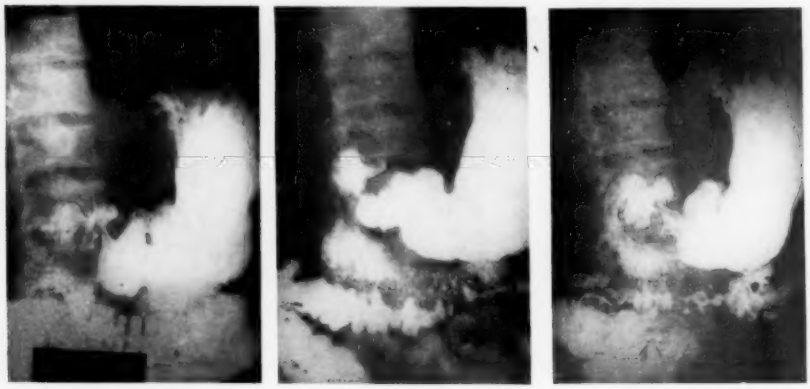


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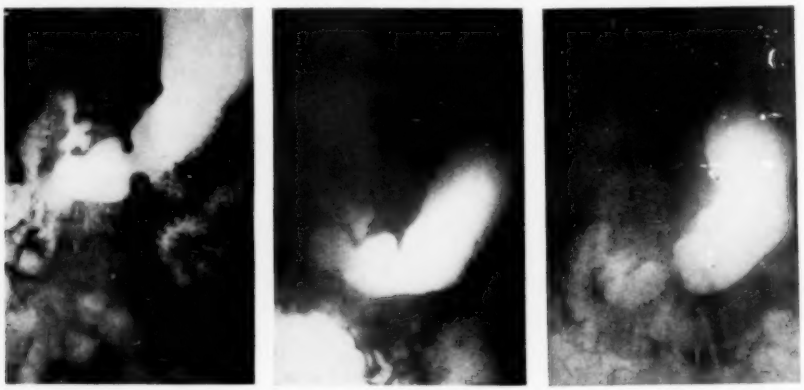
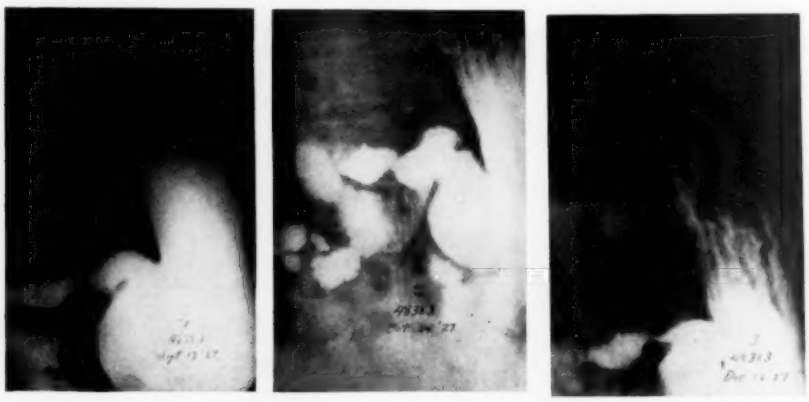
FIG. 4. A "clover leaf" deformity persisted. The second illustration shows an apparent filling out of the greater curvature due to barium in the descending duodenum. Examinations were made December, 1924, April, 1925, October, 1926.



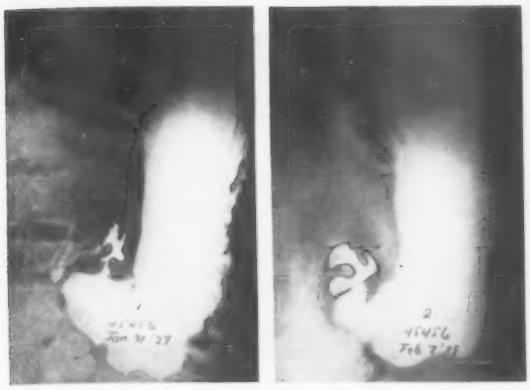
A B C

FIG. 5. Showing minor variations in a deformity which remains essentially the same. It is impossible to say whether these changes are due to variations in the activity of the disease or variations in filling.



A B C

FIG. 6. The cap filled normally at the second examination but reverted to its original deformity six weeks later.



A B

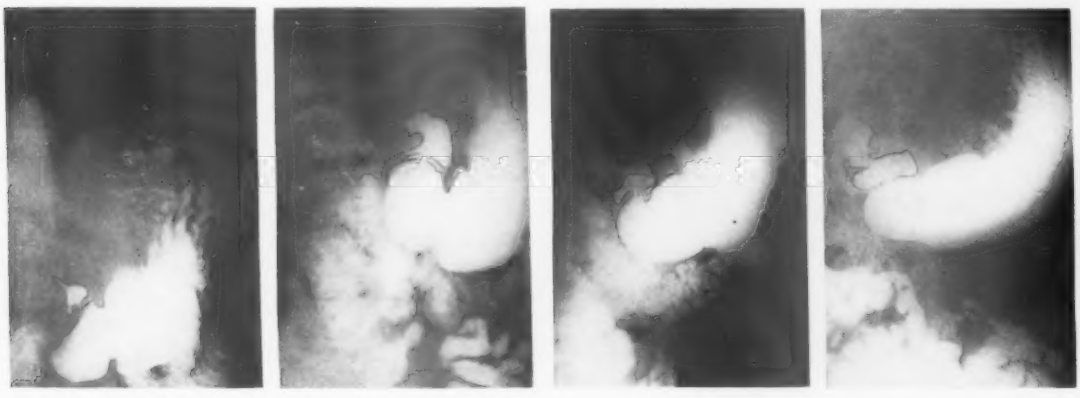
Fig. 7. The deformity has changed from a "general irregularity" to a "clover leaf type."

cap, due to changes in tone or some other reason (see Fig. 5). The third and most common source of error in serial comparisons is variation in the position of tube, patient, stomach or film. This is not so important in roentgenoscopy, where the position best showing the deformity may arbitrarily be selected and the outline drawing recorded. If the deformity is limited to the posterior wall, barium may so fill the anterior portion as to change the appearance of the deformity or to obscure it completely. Such mistakes may be made either at the time of roentgenoscopy or in the study of the films. It is advisable, therefore, to use both methods of study as a check upon each other. However, the two methods agree well. The films and roentgenoscopic examinations agreed as to the location and type of deformity in 120 of the 146 studies made. They disagreed in 22, and there was doubtful agreement in 4.

Keeping in mind the possibility of error, it was found that the duodenal deformity definitely changed in 13 instances; in 37 cases there was no change, and in 2, the change was doubtful. Figures 6,7,8 and 9 show examples of how these deformities may change.

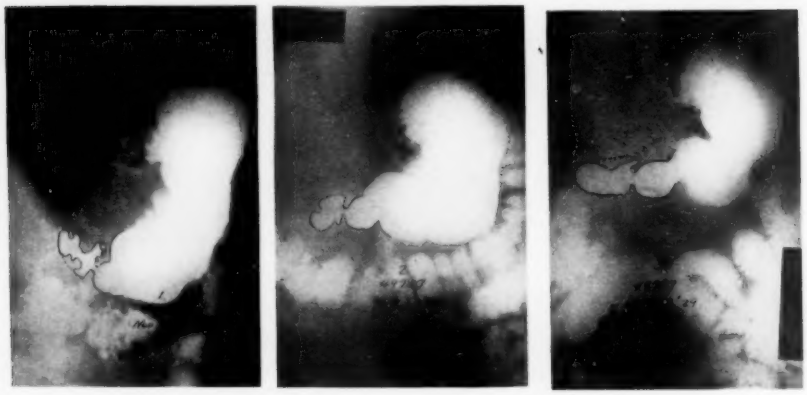
It is not clear why the deformities changed in some cases and not in others. They have been studied from the standpoint of the kind of treatment received and the symptomatic response to treatment, and no difference appeared. Thus two patients originally having a "clover leaf" deformity followed Sippy treatment for a year. In one case, the deformity changed, in the other case it remained the same. The duration of symptoms before the treatment was started also did not seem to explain the difference in response to treatment. It is possible that the difference is due to a variation in the amount of scarring present, but there was no opportunity for determining how much cicatricial tissue had formed.

From our point of view, the cause of the variation in response to treatment is not so important as that the variation occurs. Although the reason for the change is not known, it apparently can occur in almost



A B C D

Fig. 8. Showing how a deformity may change although the condition of the ulcer remains virtually the same.



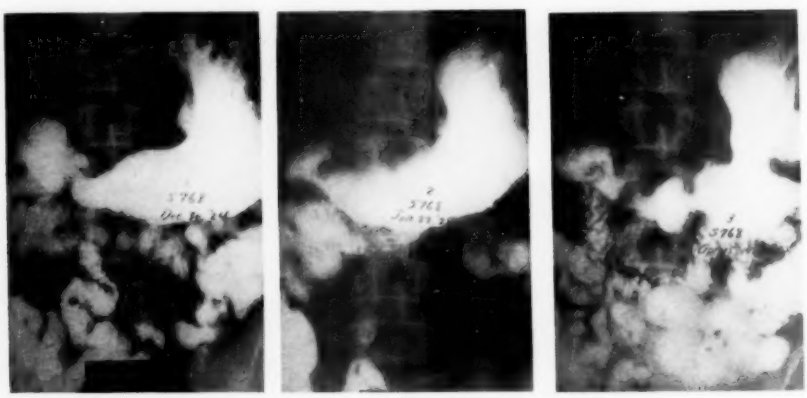
A B C

FIG. 9. Showing a gradual change from a clover leaf deformity to a mild indentation on the lesser curvature.

all the deformities. With the exception of the small contracted cap (Fig. 2*g*) each class has been observed to change in at least one instance. This means that one cannot predict much from the appearance of the cap at a single examination. Although many of these deformities do not change on later examination, the fact that they may do so precludes the possibility of deciding whether an ulcer is healed or not.

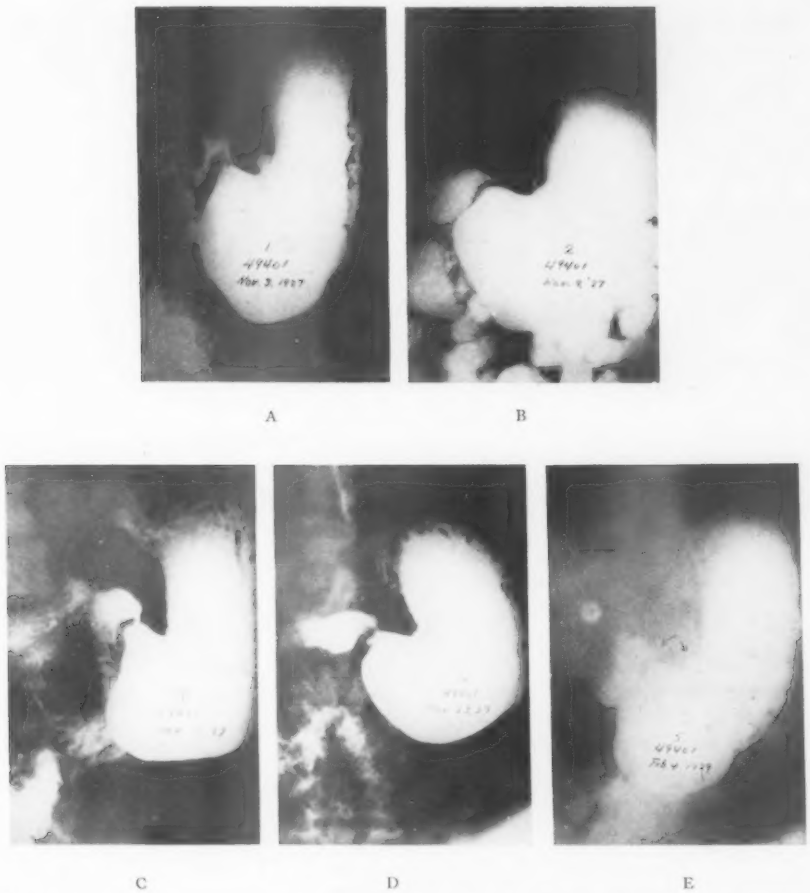
FIG. 10. The markedly deformed and constricted cap (see text).

In addition, some of the caps which did not show any gross change did show minor ones. These were produced by variations in the fingerlike projections seen in classes *c* and *f* of Figure 2. They were hard to distinguish from those due to a partial filling of the cap. Changes such as these were observed in 10 of the 52 cases. In 4 others, however, it was impossible to



A B C

FIG. 11. Showing the disappearance of a large gastric ulcer under treatment while the duodenal deformity does not improve.



A B C D E

Fig. 12. Showing apparent improvement in the gastric ulcer while the duodenal deformity becomes more marked. The last examination shows enlargement of the gastric ulcer after modifying the diet.

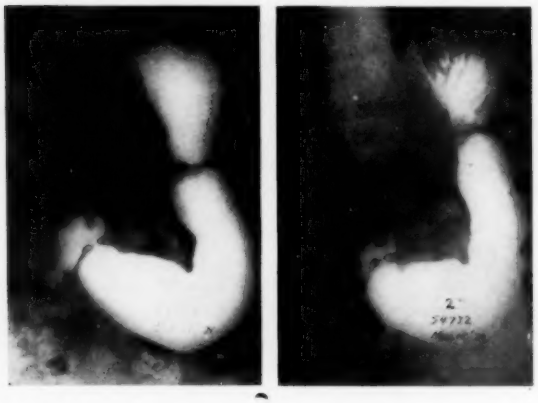
decide whether they were due to the ulcer or to differences in filling. When the latter can be ruled out, an active process is strongly suggested. By such evidence one can sometimes demonstrate by the roentgen ray that an ulcer is active, though the deformity does not vary its type.

However, an inability to demonstrate a change either by gross or minor variations does not rule out the fact that an active process is present. The following case which showed a generally contracted cap (Fig. 2, type *g*) is an excellent example:

The patient was an elderly man who had had symptoms of ulcer for twenty-five years, and had had 20 or more large hemorrhages. Figure 10 shows a markedly contracted cap shortly after the last roentgenogram was taken. The patient died following a hemorrhage. Autopsy revealed a very indurated duodenum, the lining of which was red and bleeding. The roentgen examination gave evidence of the great degree of scarring that had taken place. It could not reveal whether activity was present because there was no opportunity for spasm to occur.

We have studied cases of coincidental gastric and duodenal ulcer with the hope that they might explain the nature of the duodenal deformities. The experience in this clinic has been the same as elsewhere, that gastric ulcers disappear readily under most kinds of treatment. It seems reasonable to assume that the disappearance of the niche coincides with a subsidence of the active process, and there is some evidence for the idea that healing, even if temporary, has taken place. One would therefore expect that the active process

in the duodenal ulcer should subside also, for although gastric and duodenal ulcers may be influenced by different local conditions, there is no reason to doubt that they are due to the same cause.



A B

FIG. 13. An hour-glass stomach, with a new gastric ulcer well above the hour-glass contraction. The original ulcer causing the hour-glass deformity has healed. The new ulcer disappeared in four weeks under dietary regime and rest in bed. The duodenal deformity is evident.

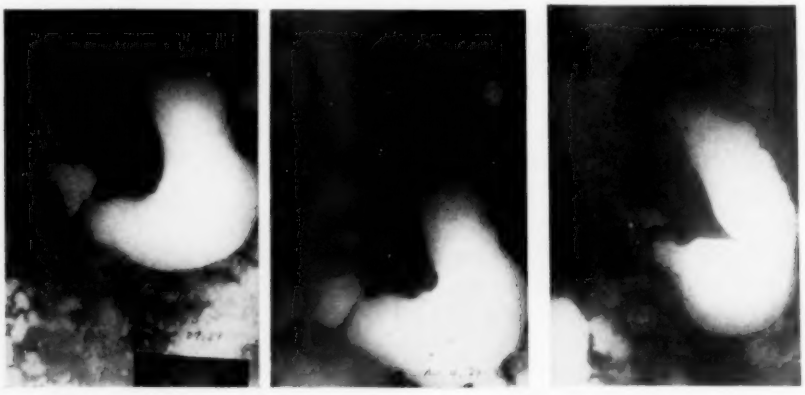
Five patients with both gastric and duodenal ulcer have been observed. In all but one, the duodenal ulcer appeared worse or no better, whereas in all but one the gastric ulcer disappeared.

Figure 11 shows a large gastric ulcer and a somewhat irregular duodenum. The patient was started on a Sippy régime. Three weeks later the gastric ulcer was smaller and at the end of thirteen to fourteen weeks had disappeared. The duodenum filled less well. This increase in the deformity can be explained by an increase in spasm, or contraction, due to scar tissue. If due to spasm, the ulcer is more active; if due to scar tissue, it may be healing.

Figure 12 again shows the gradual disappearance of a gastric ulcer after taking a Sippy diet for two weeks. The later pictures show better filling of the distal portion of the cap, although the region of the ulcer has not changed. The better filling of the distal cap suggests that there is less spasm present. This may mean a diminution in inflammation with no change in the site of the crater due to scar tissue.

Figure 13 shows that the gastric niche disappeared after one month. The films do not show the comparative condition of the duodenum as the deformity is partially obliterated in one instance by the descending duodenum. Roentgenoscopic examination revealed a more markedly constricted cap at the second examination.

Figure 14 shows similar changes. The gastric niche has gradually disappeared whereas the duodenal deformity has become more marked.



A B C

FIG. 14. The complete disappearance of a gastric niche while the duodenal deformity becomes more marked.

A B C

Fig. 15. The second examination reveals a more marked duodenal deformity than a year previously, although the patient was free of symptoms. Two months later a gastric niche appeared although the patient was still on treatment.

These 4 cases have shown a disappearance of the gastric niche which is generally accepted as evidence of healing of a gastric ulcer. As there is no reason to believe that a duodenal ulcer is a different disease from a gastric ulcer, it would be expected that the duodenal ulcer was healing also. Whatever change may be observed in the duodenum may, therefore, be construed as a change due to healing. In 3 of the foregoing cases the duodenum appears more contracted than before treatment. If healing is taking place, the greater narrowing of the cap must be due to contraction of scar tissue. One case, on the contrary (Fig. 8), shows a tendency for the flexible portion of the cap to fill better. The last case (Fig. 15) showed a greater degree of deformity after a year of fairly careful Sippy treatment than before. Originally this case showed no gastric ulcer. On treatment, however, a gastric niche developed. In this instance, an increase in the duodenal deformity was associated with an increase in activity, as evidenced by the development of a gastric niche.

These 5 patients, therefore, do not show any change by roentgen examination that can be associated infallibly with a healing process in the duodenum. In some instances, there has been an increase in the duodenal deformity associated with a decrease in the gastric deformity. If the increase in the one be considered as evidence of healing, on the basis of scar tissue formation, how shall the decrease in the other be explained? The latter may be said to be a decrease in spasm; certainly no one would say that an ulcer was worse because the deformity was less. But one cannot interpret an increase in the deformity in one case, and a decrease of the deformity in another case as evidence of healing. It is better to admit that the diagnosis of a healed duodenal ulcer by roentgen examination is, at least at present, impossible.

## SUMMARY AND CONCLUSIONS

A study has been made of the value of the roentgen ray to the clinician in following the treatment of patients with ulcer of the stomach or duodenum. The accuracy of the roentgen examination is shown to be high as compared to most kinds of laboratory procedures. However, it is a mistake for clinicians to place implicit confidence in the results of the roentgen findings and to discard entirely the older methods of investigation. It was found that a correct diagnosis was reached in 93 per cent of those patients having an ulcer. Retention as shown by roentgen examination was

found to give a true picture of clinical retention in 67 per cent of cases. The presence or absence of tenderness over an ulcer was found to have no clinical value.

A study of the roentgen findings and the clinical symptoms shows that it is not possible to diagnose a healed duodenal ulcer by the roentgen ray. Moreover, the data support the idea that duodenal ulcer is a chronic disease, which is rarely cured by treatment.*

* The authors wish to express their sincere appreciation to Dr. Merrill C. Sosman for the kindness he has shown in making available the records of the Roentgen Department, and the time and trouble he has taken in aiding them in this study.

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# ROENTGENOLOGIC FINDINGS IN A SERIES OF SEVENTY-TWO CASES OF TRAUMATIC MYELITIS DUE TO FRACTURE OF THE SPINE

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WHILE at the University Hospital, Ann Arbor, Michigan, I was given an opportunity to study a series of 72 cases of fractured spine with cord injury*. Certain findings were interesting and instructive and certain others were practically undescribed entities, which would justifiy publication. It should be emphasized, however, that this is not a statistical study because cases seen at the University Hospital certainly do not represent a cross-section of cases of fractured spine with cord injury, as seen in the emergency services of large city hospitals.

## PATHOLOGY AND MODE OF PRODUCTION OF TRAUMATIC MYELITIS

The mechanism of production of vertebral fractures and dislocations has been studied by various authors (Kocher,[4] Frazier and Allen,[3] Wilmoth,[11] Osgood,[6] and others). Indirect violence expressing itself in either forced hyperflexion or forced hyperextension of the spinal column is the most frequent cause of such injuries. Of course, there are also many cases where direct violence is the causal factor. Due to the relatively small size of the cervical vertebral bodies, an extreme hyperflexion in this region usually eventuates in a dislocation as soon as the articular processes and the ligaments give way. The upper three-fourths of the thoracic spine is a well-fixed structure and therefore is not a site of predilection for fracture dislocations. By the same token it can constitute the long arm of a lever with the fulcrum at the thoracolumbar junction and in this way cause fracture, compression or dislocation in this region (Frazier and Allen). Compression fracture of bodies of the vertebrae are usually caused by forced hyperflexion of the spinal column. Such fractures are very infrequent in the cervical region because of the relatively free mobility of the spine in this situation. Here a forward dislocation will obtain far more frequently. However, compression fractures of cervical vertebrae do occur and this series contains several such instances. Hyperextension of the spine may cause fracture of the posterior arch and the spinous process and a backward displacement of the bodies if the force is sufficiently severe. The latter is particularly true in the cervical and the lumbar regions. In the thoracolumbar region extreme hyperextension may cause chip fractures of bodies of the vertebrae (Wilmoth).

Fracture of the spine by muscular action alone has been described in the literature. Verneuil[10] reported the case of a compression fracture from extreme muscular action due to an attempt on the part of the patient to escape a fall on the ice. Aurlt (quoted by Frazier and Allen) described a fracture dislocation in the cervical region in which the patient caused the lesion by throwing the head back violently before an act of diving. Wilmoth considers extreme muscular action the usual cause for fractures of transverse processes in the lumbar region. He considers the contractions of the quadratus lumborum of primary importance in these cases.

The involvement of the spinal cord in fractures of the spine may be either direct or indirect. The cord may be directly lacerated or injured by the fractured pieces of bone. A bad dislocation may completely

* I wish to thank Drs. Hugh Cabot, P. M. Hickey and Carl D. Camp for placing at my disposal the facilities and privileges of the Surgical, X-Ray and Neurological Departments.

TABLE I

ETIOLOGY AND LEVEL OF INVOLVEMENT IN A SERIES OF 72 CASES OF FRACTURED SPINE WITH CORD INJURY

| Etiology | Cervical | Thoracic | Thoraco-lumbar junction | Total |
|---|---|---|---|---|
| Automobile accident | 15 | 2 | 23 | 40 |
| Fall | 5 | 1 | 10 | 16 |
| Diving | 4 | | | 4 |
| Direct violence | | | 5 | 5 |
| Football | 2 | | | 2 |
| Wrestling | 1 | | | 1 |
| Cases not x-rayed | | | | 4 |
| | | | | 72 |

obliterate the spinal canal and thus sever the cord, or the cord may be injured by the displacement of a portion of the spinal column at the time of injury with return to its normal position later.

The spinal cord may also be involved indirectly due to a concussion of the spinal column. Thorburn[9] describes several cases of softening of the spinal cord in gunshot wounds where no foreign body even entered the spinal canal. Thompson[7] reported a case where a bullet simply grazed the vertebral body without in any way coming in direct contact with the cord. At autopsy the latter was found to have a central cavitation with other numerous areas of softening and hemorrhage. In one of our cases (No. 134606) which came to autopsy there was complete transverse disintegration of cord substance with no accompanying bony changes except for a fracture through the sixth vertebral body. But the adjoining bodies could not have been dislocated at any time for the posterior longitudinal ligament was definitely normal and there was no abnormal movement between the two vertebral bodies.

Central softening and hematomyelia are frequent in fractures of the spine with cord injury. In this series they are most frequent in the cervical region. They are usually brought about by indirect forces. At times the macroscopic appearance may be deceiving. Thompson, commenting on central softening, emphasizes that this is usually cone-shaped, the lesion extending up and down from the point of injury. Accordingly the lower cone is more truncated. McVeigh[5] found that the liquefaction of the pulp begins in forty-eight hours, it progresses rapidly for four days and is complete within two weeks.

Edema of the cord after injury is a definite pathologic entity and is probably responsible for excessive destruction of cord substance. Allen[1] found this to be most marked at the end of four hours. McVeigh stated that edema is at its height in eight hours in his experimental dogs. In the human, apparently the edema is sustained for longer periods, for in one of our cases coming to autopsy (No. 205271) there was marked edema of the cord about two days after injury.

Extra- and intradural hemorrhages were insignificant in 6 cases which came to autopsy. There certainly was not enough hemorrhage to cause pressure symptoms. This is in harmony with the experience of previous investigators (Elsberg, Thorburn, Thompson).

Subpial and subarachnoid hemorrhages are also seen frequently. In 3 cases localized subpial hemorrhages were observed at operation. It is probable that these are of no immediate serious consequence except that in the process of healing they may add to scar tissue formation and exert localized pressure.

In cases of old fractures of the spine with cord injury, irregularities and narrowing of the canal, and adhesions between the cord and membranes have been observed. Localized arachnoiditis has been described by Elsberg.

### ROENTGENOLOGICAL FINDINGS

The importance of roentgen examination in fractures of the spine cannot be overestimated. In a certain group of cases it is of extreme diagnostic value. It is a good

policy to have roentgenograms of all cases of acute fracture before any operative procedure is considered. It is at times very difficult to get good films, particularly when the injury is in the upper thoracic and lower cervical regions. Anteroposterior exposures are of value in noting changes in the various processes of the vertebrae and an expert eye may even note compressions and angulations. But it is surprising to note that the anteroposterior view in a bad fracture with much angulation shows very little as compared with lateral exposure films. It is important therefore to have good lateral plates. In the lumbar and lower thoracic regions these are usually obtained with little difficulty. In the upper thoracic region much depends on whether the patient is fat or lean. In the cervical region it is important to use good technique in order to include in the lateral exposure the seventh cervical and as many of the thoracic vertebrae as possible. It is well-known that most of the cervical fracture dislocations are between the fifth and sixth, sixth and seventh cervical and the seventh cervical and the first dorsal vertebrae. Unless care is taken, this region will be completely obscured by the adjacent structures composing the shoulder girdle. The method devised by Dr. Hickey for lateral exposure in acute fractures of the cervical spine is very helpful.

The patient is placed on a table. The roentgen tube is arranged to transmit its rays on the lateral aspect of the neck. The cervical spine is immobilized by one assistant making traction on the head and two others pulling down on the upper extremities. The film is placed against the head and neck and held there by means of sandbags, etc. By this method a very good view of the lower cervical spine is obtained.

The roentgen findings are analyzed in the following paragraphs. Here again it should be emphasized that the present series does not represent a true cross-section of cases of fractured spine and therefore should not be considered in that light. All but 4 cases were roentgenographed and practically all of the films are satisfactory for detailed study. By far the greater majority of the cases had injury at the lower cervical and the lower dorsal and upper lumbar levels. The following tabulation gives the distribution of lesions:

| | Cases | | Cases |
|---|---|---|---|
| Cervical | 1st—1 | Dorsal | 6th—0 |
| " | 2nd—1 | " | 7th—0 |
| " | 3rd—1 | " | 8th—1 |
| " | 4th—2 | " | 9th—1 |
| " | 5th—13 | " | 10th—1 |
| " | 6th—13 | " | 11th—3 |
| " | 7th—5 | " | 12th—8 |
| Dorsal | 1st—1 | Lumbar | 1st—15 |
| " | 2nd—1 | " | 2nd—5 |
| " | 3rd—2 | " | 3rd—2 |
| " | 4th—2 | " | 4th—1 |
| " | 5th—2 | " | 5th—1 |

In a small group of cases, although the clinical findings were those of a partial myelitis on a traumatic basis, roentgenograms failed to show any pathology sufficient to explain the disability. A brief summary of these cases follows:

J. S. (Case No. 171717) was in an automobile accident following which he was completely paralyzed in all four extremities. Within two days he regained partial function of the left arm, and a few days later he began moving the left lower extremity. About one month after the accident function began to return in the right side. About a year later he complained of burning in the lower extremities and stiffness, particularly in the left lower limb.

Examination showed spastic quadriplegia along with hypalgesia and thermoanesthesia on the left side from the level of the tenth dorsal spinal segment. Roentgenograms of the cervical, dorsal and lumbosacral spine failed to reveal any abnormality.

P. L. (Case No. 179841) was struck by a car on April 15, 1925. Paralysis of all four extremities ensued. Both bladder and bowel were paralyzed. Examination on Oct. 5, 1927, showed a spastic quadriplegia, particularly involving the right side. Roentgenograms of the cervical, dorsal and lumbosacral spine did not show any lesion to explain the clinical findings. Several roentgenograms were taken a few days after the injury.

A. J. H. (Case No. 210202) was in an automobile accident on Oct. 14, 1928. He was com-

pletely paralyzed in all four limbs. In about three days he began to move the left upper and lower extremities. About one month after the accident he was able to walk with support. On Feb. 4, 1929, he had a definitely hemiplegic gait. Reflexes were increased on the right side. There was definite loss of pain and temperature sense in the left half of the trunk and left lower extremity—evidently a Brown-Séquard type of spinal cord involvement. Roentgen examination failed to reveal any lesion except fracture of the spinous process of the fifth cervical vertebra with very little displacement.

The above cases indicate the presence of cord involvement and injury without accompanying evidence of fractured spine. This finding may be explained by the assumption: (1) that the roentgenograms did not show the bony changes present; (2) that a displacement at the time of injury slipped back into position, and (3) that in reality there is no bony change and that the cord injury is caused by impact.

Another interesting group of cases are those in which the level of the injury as shown in the roentgenogram does not correspond to the spinal cord segment involvement brought out by neurological examination.

For instance, in one case (No. 200555) the patient showed an involvement of the spinal cord at the level of the sixth cervical segment. Roentgen findings were negative for the cervical spine. The only abnormality noted was in the fifth dorsal vertebra where the spinous process was fractured. In another case (No. 199267) the patient showed neurological signs of involvement at the level of the seventh cervical segment and roentgenograms were indicative of a longitudinal fracture through the bodies of the third and fourth cervical vertebrae.

Should these cases be explained on the basis of displacement followed by reduction? Particularly when the cord lesion is above that of fracture shown by the roentgenogram, can ascending softening be responsible for the changes noted, or will these cases have to be explained on the basis of multiple injuries? The third suggestion is probably the most plausible, though there are points in favor of the other two. An ascending softening is not infrequently seen at autopsy and in one of our cases the cord was definitely soft and jelly-like about 4 cm. above the level of compression. One of the above-mentioned cases died, but unfortunately there was no autopsy.

The most common roentgen finding in this series was compression fracture of the bodies of vertebrae. This is in accord with reports in the literature. Osgood[6] in reviewing 242 cases of fractures of spine noted that a little over 40 per cent were compression fractures. In 70 to 80 per cent of the latter the body involved was either that of the eleventh or twelfth dorsal or the first or second lumbar vertebrae. In about 50 to 60 per cent the twelfth dorsal or first lumbar vertebrae were the ones involved. In this large series he found no cases of compression fracture of the cervical or upper thoracic region. Frazier and Allen in their book on the surgery of the spine report a case of compression fracture involving the third, fourth and fifth cervical bodies. Kocher, reporting 23 cases of compression fracture, found that 16 were in the thoracic region, 7 in the lumbar and none in the cervical region.

In this group of 72 cases there are 32 compression fractures. These were distributed as follows: lumbar, 19, dorsal, 7, and cervical, 6. The first lumbar was involved in 11 cases, second lumbar in 5, third lumbar in 2 and fourth lumbar in one case. In the dorsal group there was one case of compression of the tenth, one of the eleventh and five of the twelfth dorsal vertebra. There were 2 compression fractures of the seventh cervical, 3 of the fifth cervical and one of the fourth cervical vertebral bodies.

Compression of bodies of vertebrae in the cervical region (Figs. 1 and 2) has been rather frequent in this series. The mechanism of production is most probably one of compression of a given body between the impact and the weight of the body. Most of the cases have sustained this type of fracture in diving or accidents where they fell down head first in such a way that the

Fig. 1. Compression fracture of the fifth cervical vertebra. The film was taken about eleven months after injury. Patient showed signs of central cavitation of the cervical spinal cord.

head and neck had to support the trunk and extremities.

For instance, in one case (No. 211268) the patient dived into shallow water. He was completely paralyzed in all four extremities. Examination about six months after the injury showed a Brown-Séquard type of cord involvement. Roentgen findings were indicative of a definite compression fracture of the fifth cervical vertebra. In another case (No. 142972) the patient jumped off of a train. She was completely paralyzed in all four limbs. Examination at various intervals showed the presence of a quadriplegia. Roentgen examination was indicative of a compression fracture of the fifth cervical vertebra. G. L. R. (Case No. 174613) was in an automobile accident, following which she was completely paralyzed in all four extremities. Examination at various intervals brought out a spastic paraplegia. Roentgen findings were indicative of a compression of the fifth and sixth cervical vertebrae. Another case (A. L., No. 201693) showed a compression fracture of the seventh cervical vertebra and a dislocation of the sixth cervical anteriorly. He was completely paralyzed after the accident. His paralysis cleared up in a very short time except for a slight weakness of the left upper extremity. D. R. fell down stairs. She was paralyzed in all four extremities. Examination at various intervals showed a definite spastic paraplegia. Roentgen findings were indicative of a compression fracture of the fifth cervical vertebra. G. B. (Case No. 224887) came to the hospital for an appendectomy. In the routine history and physical examination, it was discovered that he had a compression fracture of the fifth cervical vertebra, sustained in a diving accident (Fig. 2).

Compression fractures of the cervical vertebrae are usually associated with chip fractures. It is interesting to note that in most instances the patients show definite signs of hematomyelia whereas spastic paraplegia is the most common sequel.

Fig. 2. Compression fracture of the fifth cervical vertebra. The film was taken seven weeks after injury.

FIG. 3. Longitudinal fracture through the bodies of the third and fourth cervical vertebrae.

Comminution of bodies of vertebrae is a frequent finding in severe injuries of the spine, but longitudinal fractures through bodies of vertebrae is a rare occurrence and difficult to diagnose in the roentgenogram. Kocher pictured a longitudinal-oblique fracture through the lower thoracic vertebrae. Thorburn described a symmetrical longitudinal fracture through the thoracic vertebrae due to gunshot wound. In the present series we have been fortunate in having a case where such a fracture was conclusively proved to be present at autopsy. From the roentgenologic standpoint we have had 3 cases which were suggestive of a longitudinal fracture through bodies of vertebrae. A brief summary of these cases follows:

L. M. (Case No. 199267), aged sixteen, dived in shallow water, following which he was completely paralyzed in all four extremities. There was also complete anesthesia to about the level of the second intercostal space, with hypalgesia involving the upper extremities up to about the level of the seventh cervical segment. There was paralysis of bowel and bladder. In about two weeks all sensory changes disappeared. In about $3\frac{1}{2}$ months patient was able to wiggle the toes and feed himself. On entrance the manometric spinal fluid pressure showed no block. Roentgenograms showed a definite line through the bodies of the third and fourth cervical vertebrae (Fig. 3). A diagnosis of longitudinal fracture was made. Although we have no films of his cervical spine before injury, the linear change in the vertebral bodies is such as to exclude the possibility of a spina bifida in this situation.

E. F. S. (Case No. 200441) fell 6 feet on Nov. 2, 1927, landing on his head. He was completely

FIG. 4. Longitudinal fracture through the bodies of the twelfth dorsal, first and second lumbar vertebrae. This was corroborated by autopsy findings.

paralyzed in all four extremities. There was rectal and vesical paralysis. By March, 1928, he was able to walk. Examination at that time showed irregular pupils, arms and legs were very weak, there was a slight spasticity in all four limbs. There were sensory changes up to about the level of the sixth cervical segment. Roentgen examination showed a fracture line through the body of the fifth cervical vertebra.

B. F. R. (Case No. 198783) fell off a ladder from a height of 35 feet landing on his back. He was paralyzed in the lower extremities and right arm. Roentgenograms showed much comminution and a line through the bodies of the twelfth dorsal and the first and second lumbar vertebrae (Fig. 4). At operation the laminae of the twelfth dorsal, first and second lumbar vertebrae were found to be fractured and displaced. There was much extra- and intradural hemorrhage. There was a tear through the dura. He died soon after the laminectomy. An autopsy was performed. Both transverse processes of the first lumbar, the left transverse process of the twelfth dorsal and second lumbar vertebrae were fractured. A longitudinal fracture extended from the lower part of the twelfth dorsal through the first to the upper part of the second lumbar vertebra. The fracture line was practically in the midline. There was also a laceration of the anterior longitudinal ligaments in the line of the fracture.

Fig. 5. A case of fracture dislocation of the seventh cervical vertebra. Patient showed no subarachnoid block and he was treated conservatively. The sensory and motor symptoms cleared up practically completely. The films taken at the time of injury did not include the lower cervical spine and the condition was unrecognized until about three months later when the above exposure was made. This case proves the importance of including the lower cervical spine in the film and not being satisfied until satisfactory exposures are procured. It is interesting to note that with the deformity sustained the patient did not have an injury of the cord.

Fig. 6. This is to show a fracture dislocation between the atlas and the axis. Note that the anterior arch of the atlas is fractured. The odontoid process of the axis is apparently intact and is in close proximity to the posterior arch of the atlas.

Particularly the third case affords conclusive evidence that longitudinal fractures may occur through the bodies of the vertebrae. It is rather difficult to understand the mechanism of production of such lesions. In the case of the first two examples the etiologic factor was a direct fall on the head. The changes noted were both in the cervical region. In the third case the patient fell on his back a distance of 35 feet. It is possible that the impact pushed the spinous processes in the lumbar region forward causing a fracture of the laminae and pressure against the same in such a way that the vertebral pedicles were spread apart with consequent splitting of the bodies of vertebrae into two longitudinal pieces.

Fracture dislocations are rather frequent in this series. They are mostly in the cervical region. Those in the thoracic and lumbar regions are more often fractures associated with displacement of bodies of vertebrae. Anatomically the 18 cases of this type are distributed as follows: one between the first and second cervical; one between the second and third cervical; 3 between the fourth and fifth cervical; 7 between the fifth and sixth cervical; 4 between the sixth and seventh cervical; one between the ninth and tenth thoracic; one between the eleventh and twelfth thoracic; one between the twelfth thoracic and first lumbar; one between the first and second lumbar; one between the second and third lumbar vertebrae. It can be seen, therefore, that fracture dislocations are most frequent between the fifth and sixth cervical vertebrae in this group, which is in agreement with other investigators (Frazier and Allen).

FIG. 7. This is to show a fracture dislocation between the axis and the third cervical vertebra. It is surprising to note that with such marked displacement the patient was practically symptom-free.

Figure 6 shows a fracture dislocation between the atlas and the axis. Careful study of this film showed a posterior dislocation of the odontoid process with fracture through the anterior arch of the atlas. The patient's spinal cord was undoubtedly lacerated between the odontoid process and the posterior arch of the first cervical vertebra. There was also a rotation deformity of the atlas over the axis. Here again it is interesting to note that the level of anesthesia was to about the seventh cervical segment, with bowel and bladder paralysis and he was able to move the arms. The patient died. Autopsy was not permitted.

FIG. 8. Showing a fracture dislocation of the tenth dorsal vertebra. Note the extent of the angulation.

Figure 7 shows a fracture dislocation between the axis and the third cervical vertebra. The patient (A. S., No. 213969) was in an automobile accident in May, 1927. Immediately after the accident he showed no signs of paralysis. In his case there has been no sphincter disturbance.

About ten months after injury he was normal in all respects except a feeling of coldness and numbness in the left lower extremity. Examination showed definite limitation of motion of the head in all directions. There was some sensory dissociation in the left leg. It is surprising that with such pronounced dislocation the patient emerged from the accident without any paralysis.

At times the extent of dislocation or angulation is such that the cord is undoubtedly severed. But it is surprising to note cases with extreme angulation and distortion of the spinal column which still show signs indicative of conduction of impulses through the injured area. Thus E. L. (Case No. 84404) whose lateral exposure film is included (Fig. 8) had sensation in the lower extremities, and the bowel and bladder functions were normal.

It is not within the scope of this paper to go into any further detail concerning roentgen findings in fractures of the spine. Suffice it to say that roentgenograms are an important help in the diagnosis and treatment of these lesions. At times they give decisive evidence concerning the operability of a given case. But we should also remember that to depend upon roentgen examination alone would be a grave mistake, at least in certain cases. It is the conclusion arrived at from a combination of various data that should act as a guide in the care of the patient.

SUMMARY

Roentgen studies are important in cases of fractured spine with cord injury.

Lateral exposure films should always be be taken in these cases.

Compression fracture of the cervical vertebrae is rather frequent and several instances of this type are described.

Longitudinal fracture through the bodies of the vertebrae is a possibility and can be diagnosed from the roentgenogram.

Although films can be of aid in diagnosis, they should always be considered in association with other methods of clinical and laboratory approach. Some cases of certain transection of the cord on the basis of roentgen findings may not show any signs of cord damage even on neurological examination.

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# A DISCUSSION OF THE METHODS USED FOR MEASURING ROENTGEN-RAY APPLIED INTENSITY

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EVER since roentgen rays and radium were discovered, there has been dissatisfaction with the methods which have been proposed or employed for measuring their intensity. Since the inaccuracies of each of these methods have been discussed in the literature, every radiologist should know that the chemical and biological as well as the mechanical methods cannot be depended upon in measuring the intensity or quality of radiation, or what has been commonly called "dosage."

When the roentgen rays became generally employed in the treatment of disease, it was found that there is a limit to the amount of radiation which can be applied to the human skin without causing undesirable sequelae. This limitation, manifested by various degrees of redness or tanning, was called the "erythema reaction." It is unfortunate that this reaction of the skin has been retained as a biological standard of dosage in therapy, and that we still try to employ it to determine the effects of radiation, and visualize it to limit treatments. Erythema means only redness. The term in no way explains the effects of radiation on pathological lesions. The degree of redness depends upon many factors such as the acuity of color vision of the observer, the interval of time elapsing between the administration and observation, the complexion and age of the patient, the ability of the vascular system to react, the volume and characteristic structure of the subcutaneous tissues which are irradiated, to say nothing of physical factors, such as the quality of the rays.

A unit of erythema has been defined as "that dose which in 80 per cent of cases treated produces a faint reddening or bronzing of the skin in from ten to twenty days, and in the other 20 per cent produces no visible effect." Another definition is: "An erythema dose, or skin tolerance dose, is the amount of radiation that will produce defluvium of the scalp in three weeks, or a pronounced reddening of the skin in a young blonde, on some sensation area in about five to seven days after radiation." These definitions indicate that the erythema dose, or the erythema reaction, is inconstant and indefinite. According to the first definition, in at least 20 per cent of cases the reaction does not occur. It would seem, therefore, that such a unit would be unsatisfactory as a standard or as a measure for comparison of physical factors because if the erythema reaction were considered to be constant, then in at least one-fifth of the instances, one could not be sure that physical factors had been correctly controlled. On the other hand, if we assume that the physical factors have been accurately controlled and there is at least 20 per cent variation in skin manifestations, it is apparent that in a large proportion of instances the erythema reaction must fail as a standard measure of physical factors.

The second definition in its first phase bases the erythema reaction upon the epilating effect, and in its second phase upon about one-half of the latent period of the first definition and even specifies a blonde skin and a sensation area. Neither of these definitions takes into consideration the influence of different qualities of radiation. For example, when using hard radiation, epilation occurs with about 50 per cent of the intensity which will cause an erythema, while with softer radiation a much larger dose is required. With the softest radiation (Grenz rays) there is no epilation whatever. Moreover the fact that the definition requires a sensation area indicates that even in the same individual the skin reacts differently in different regions of the body.

A unit erythema dose cannot be divided

on the basis of the degree of skin reaction because less than that amount of radiation intensity which should cause a certain degree of redness will produce no visible erythema. Moreover, although in the past we have assumed that a certain proportion of the applied intensity or of the period of application of radiation will produce an exactly proportionate and similar tissue response, we have sufficient evidence to prove that from a biological viewpoint this theory is entirely erroneous. There is not, and never can be, a standard procedure for the application of therapeutic radiation, either as to intervals between treatments or as to the intensity or quality employed. In the case of roentgen rays and radium, therefore, we find that there are individual indications and personal preferences for intensive, divided or saturation technique, which have been shown to produce very different biological effects in pathological and normal tissues. It is obvious, then, that we cannot measure or analyze the results of these different techniques by erythema reaction when the skin unit is established on the basis of an erythema which is produced at a single application. These methods of administering treatment may be limited by the reaction produced in the normal skin; however, their effectiveness does not depend upon the skin reaction but upon the energy which reaches a certain volume of pathological tissue and is absorbed in a specified period of time. Therefore, the "erythema dose" cannot be used as a standard for indicating the results of tissue response of different methods of treatment.

No study of skin reaction has disclosed the reason for the effect of radiation on diseased tissues *in vivo*, although we have assumed that with equal intensities the vascular reaction in the deeper tissues is similar to that which takes place on the surface. It cannot be stated positively how these vascular changes affect a neoplastic process, and we have evidence that the somewhat temporary interference with the vascular supply which may be produced by radiation is of secondary importance as compared with the direct destructive effect upon neoplastic cells. Normal skin and malignant tissues are usually of dissimilar histological structure and biogenesis, and *in situ* probably have little in common either as to the degree or kind of reaction to radiation. This is illustrated by the well-known fact that most malignant processes which develop in the skin require vastly more radiation to destroy them than does the normal skin, and that for each malignant tissue—and probably for normal structures as well—there is an optimum destructive intensity. Also the intensity which reaches subcutaneous areas is much less than that which produces the skin manifestation, and is of an entirely different quality, so that the radiation which affects the deep tissues no doubt causes very different effects from those produced by direct radiation, which is measurable. Therefore, the skin erythema dose cannot be applied as a measure of the reaction of pathological tissues to radiation.

Perhaps the most accurate and valuable study of the underlying causes of radiation erythema was originally developed by David and Gabriel who examined the skin capillary reaction by means of special microscopes. This is, of course, a study of the effect of the application and gives no information as to the degree of intensity which is applied, or the degree of reaction which may be anticipated, nor do the originators of this investigation make any such claim for it.

In addition to the skin reaction, several other biological standards have been advocated. For example, it has been suggested that germinating beans (Jüngling), *Ascaris* eggs (Holthusen), and the ova of *Drosophila melanogaster* (fruit fly) (Mavor, Packard and Wood), be employed to standardize radiation effects. We have had some experience with each of these methods and the last seems to be the most practical one for laboratory investigation. Later, we hope to report some of the results which we have obtained with it. However, at this time we may say that the procedure is

not so simple as one might be led to believe. It is not simply a matter of enticing some fruit flies into a bottle, housing them, and by feeding them upon a proper diet, encouraging them to lay an unlimited supply of eggs to be used *ad libitum* in the laboratory or upon patients. The rearing of these insects is fraught with many complexities with which clinicians have neither the facilities nor the time to deal. These flies, like human beings, are temperamental, and have their gastronomic fantasies and sexual idiosyncrasies; they are subject to diseases and hazards of existence which influence their reproductive activity, the mortality rate and the maturation of the ova, so that sometimes it is difficult to draw accurate conclusions as to the effects of radiation upon them.

It would seem, therefore, that biological methods as standards for estimating the degree of reaction to radiation are unsatisfactory because the reaction of cells or any organism is entirely too variable to be an index of physical mensuration. To attempt to adopt biological methods for the measurement of such physical agents as roentgen or radium rays would seem to be as consistent as to try to measure the heat of a flame by the degree of browning of a steak, or to estimate a mile by the respiratory rate of a runner.

I do not wish to imply that we should entirely disregard the skin of the patient, but after all, the only skin manifestation in which the radiologist is really interested, as far as the effects of his treatments are concerned, is the "tolerance limit." This has been variously named "skin tolerance dose," "maximum erythema dose," etc. Since the term "dose" in a physical sense, is ambiguous, a better term might be "applied intensity," and we might substitute the term "radiation tolerance limit" for the many expressions used in the attempt to describe any limit of tissue tolerance. We must remember, however, that "tolerance limit" is also a rather indefinite term on account of differences in biological reactions which are dependent upon the physical factors which cause them, and upon the metabolic status of the patient's skin at the time of treatment, which in turn depends not only upon the condition of the vascular system as a consequence of certain diseases or of age, but also upon the area of the body which is being treated, and the impressions of the observer. There never can be an absolute "standard minimum," "standard threshold," "standard maximum" or "standard tolerance limit" of erythema skin reaction. As a matter of fact, all of the terms which apply to the reaction of the skin are expressions for the safe limits which are imposed upon the radiologists by the rest of the medical profession, the law, and insurance companies, without regard to the nature of the condition which is being treated, or the judgment and skill of the therapist.

Of course, there is a limit beyond which the radiologist dare not proceed, but this tolerance limit should not be expressed in terms of redness or bronzing but in physical units of measure, a certain number of which, administered under specified conditions, within a stated time, and with a definite quality of radiation, will be the average limit of skin tolerance. We must remember also that the tolerance limit or any other term used to indicate the safe skin reaction is only an average and is not at all indicative of the intensity which is applied to an area under treatment, and is therefore not a measure of the reaction which will take place in a diseased tissue, although this may be calculated on the basis of the percentage absorbed.

The dissatisfaction with the old methods of describing and measuring radiation intensities led to the really epoch-making suggestion of Szilard and Villard, which was later developed by Duane and Friedrich, that a standard physical unit of radiation intensity might be established on the basis of another property of short wave lengths known as the ionization of gases and that the resultant electrical effect of this ionization could be measured as a current in terms of the universally accepted

electrostatic unit. The apparatus which was used to measure the ionizing effect was what is now called the "air ionization chamber," and the electrical current produced was measured by means of the galvanometric or the electrometric method.

Extensive investigations have amply confirmed the original work of these investigators and the practicability of the method, many details of which have been perfected. During these investigations numerous and varying types and arrangements of the original air ionization chambers have been employed in widely separated laboratories, in each of which experiments showed that certain mechanical details of design were preferable or essential in order to obtain the most accurate and constant results. These different mechanical factors, each of which influences the measurements of radiation, have now come to be very well known by experienced investigators.

After several years, a comparison was made of the results which had been obtained in a number of laboratories where somewhat different mechanical systems had been employed. It is most gratifying, although not particularly remarkable, that these results agreed within very narrow limits of experimental error.

As the result of this agreement, the ionization method of measuring roentgen-ray intensities was accepted at the Second International Congress of Radiology in 1928, and on this basis a standard physical unit was defined. It is worthy of remark that the committee of the Congress was wise enough not to establish or suggest a specific design for a standard air ionization chamber. This decision was owing, no doubt, to the fact that those members who had actually carried on researches with air ionization chambers were already familiar with the different types, their modifications, and numerous details of construction, and recognized the restrictions and limitations which are necessary in order to obtain accurate measurements, and they appreciated that there can be little deviation from certain fixed principles. This applies particularly to such minutiae as diaphragm placement, the size and shape of the diaphragms and their relation to each other, or to the electrodes, and the focus of the tube, and also to the air volume and electric saturation and distribution of the electric fields of the chamber.

Undoubtedly, the next International Congress will find it necessary to make a definite regulation for a preferred design of a standard air ionization chamber in order to remove the doubts in the minds of some physicists and many clinicians who are uncertain as to the accuracy of the "r" as a unit, because of the apparent dissatisfaction of a few who seem to be unwilling to accept the conclusions which have been reached by others. Some dissenters are quibbling about details which have been long understood by those who have actually carried on investigations, and who have had sufficient experience to know which methods are accurate and practical. These dissenters, however, cannot destroy the general principles which underlie this internationally accepted method for measuring short wave length radiation intensity, nor do they present a better method, and their destructive criticisms do not detract from the excellent results which have been achieved. It is enough to know that an international body of eminent physicists and clinicians have come to a complete agreement after a prolonged, painstaking study of the entire problem.

The greatest possible accuracy in determining both quantity and quality is essential in the research or standardization laboratory. It is desirable also in clinical application, but here we are permitted much more latitude.

The factors which influence the measurement of intensity by means of air chambers and the influence of these factors on the accuracy of determinations are so well known by experienced investigators that further discussion is unnecessary. In practical experience, many of these minor factors will not affect, beyond safe limits, the amount of radiation which is applied to a patient,

although they do influence the standard unit to a slight degree. Therefore, the clinician is not interested in arguments about minor features which do not influence the method as a whole, or discussions of non-essentials which only tend to confuse and discourage him. It would seem that it is necessary only that physicists agree upon a practical working scheme and design of a standard chamber, whether or not it is theoretically ideal. During this period of transition it is desirable and even necessary for clinicians to have confidence in the theory and practicability of the r as a standard of physical measure, and they may be assured that there is no such thing as a new type of air ionization chamber which will in any way influence the r as a unit. Of course, from time to time, some one will advocate archaic or unusual arrangements which may change the appearance of the air chamber, but will not affect its performance in any way that has not been demonstrated previously or discarded.

The question of the site at which applied intensity is to be measured in therapy would seem to be a matter of personal preference. However, it should be obvious that it is the amount of radiation which is applied to the patient under certain conditions that is important and must be measured, and not the intensity at any other point. In our clinic we have always advocated the direct method of measuring applied intensity because we prefer to measure at the site of application on the patient. After a number of years of experience and a trial of both the indirect and the direct method, we have found the direct method with a small ionization chamber to be accurate and very simple, not only because calculations, which yield a high percentage of error are eliminated, but because the total applied intensity which the patient actually receives is included in the measurement irrespective of (1) the potential, (2) the filter, (3) the amperage, (4) the distance, (5) the size and shape of the field, (6) the volume of tissue, and all of the other indeterminable factors which influence direct and scattered radiation. We have been especially satisfied with this method since the development of the small air wall type of ionization chamber because we can duplicate or measure accurately the applied intensity of any quality of radiation which we use ordinarily in therapy.

However, in another laboratory, it may be thought preferable to measure the intensity in air at an arbitrary distance from the focus and attempt to estimate the amount of backscattering on the basis of that which takes place in a phantom, and then attempt to interpret these findings in the terms of applied intensity on the patient. It is apparent that all of the six factors which I have enumerated must be taken into consideration in calculating the amount of intensity which is applied at a treatment.

It has been stated that there would be less error if the applied intensity were measured, under fixed conditions, in a phantom, and the standard results applied to patients, because the backscattering from the phantom is always the same. Unfortunately, the backscattering from patients is never the same, and is always different from that from a phantom. These are exactly the differences in which we are interested and which must be taken into consideration, which cannot be done accurately by any indirect method. We are concerned with the intensity which affects the patient, and not with the influence of the radiation on a box of wax.

These observations apply also to the method of calculating the applied intensity by means of standard absorption charts and of measuring or controlling the intensity output with large ionization chambers. The large chamber is usually placed near the tube or under the filter so that only the focal radiation is measured. This method is very valuable as a method of controlling the intensity output, but does not measure the total applied intensity since scattered radiation must be calculated. Those who use these large chambers and criticize the small chamber method lose sight of the fact

that the small chamber may also be used in the same locations in which the large chamber may be used and also has many other advantages, and can be used for any quality of radiation.

Those who employ these indirect methods and standard charts with percentage allowances for backscattering cannot take into consideration the fact that the backscattering varies considerably in different regions of the body. For example, between the chest and lumbar fields, there is a difference in backscattering of approximately 15 per cent. Also, the amount of scattering depends upon the wave length employed, increasing as the wave length shortens. The shape of a field is as important as its size since the scattering from a square field 10 by 10 cm. is not the same as that from a field 5 by 20 cm., although they each contain 100 sq. cm. Also, the amount of scattering from a field which has a depth of 5 cm. is very different from that of a field of the same size but with greater or less depth. By indirect methods it is impossible to take all of these points into consideration, as can be done by the direct method.

It is obvious, then, that the direct method of determining applied intensity is more accurate and is easier than any indirect method. It is probable, however, that the inaccuracies which exist when the indirect method is used do not influence the therapeutic results to a very great extent, and it is certainly preferable to use it than not to determine the applied intensity at all. It would seem to me that if any one can go through the elaborate calculation required by the indirect methods in order to arrive at a conclusion as to the applied intensity, he would be even more capable of carrying out the direct method by means of a calibrated dosimeter, and would be aware of the factors which influence the method. One who is familiar with such details could certainly detect and correct inaccuracies in dosimeters, which are now constructed so that they are practically foolproof, and are provided with scales calibrated in "roentgens" so that the applied intensity may be read directly by timing the discharge rate with a stop watch.

This brings up the question, "How accurate should we be in estimating and applying radiation?" I am of the opinion that therapists should be as accurate as is practically possible. Too many therapists treat patients rather indifferently and apply only what they choose to call their own "standard erythema dose," irrespective of the condition of the patient, the size and shape of the field, or the disease for which the patient is being treated. This is fairly safe, but as a rule the patient does not receive the maximum benefit, and the therapist, as well as other members of the medical profession, is led by this negligence to become skeptical of the value of radiation therapy. Thus the radiologist defeats his own ends. If we are ever going to be able to draw conclusions as to the biological effects of radiation we must measure the applied intensity and quality as accurately as possible in terms of established physical units.

It is stated frequently that too much attention is paid to the physical side of radiation therapy and physical mensuration, and that the medical side is neglected. Obviously, these statements are inconsistent because the present effort is to protect the patient and to attempt to understand the biological processes which take place in his tissues as a result of the application of a known quality and quantity of radiation, as well as to provide a common ground for the intelligent recording of methods and results.

The establishment of an accurate method of measuring dosage is an attempt to escape from archaic and haphazard methods of some who believe that they possess some mystic sense whereby they can predetermine specific indications, individual variations, radiosensitivity, and other reactions. Materia medica did not emerge from this same dark cloud of empirical therapeutics until physiological reactions were studied in relation to definitely known qualities and amounts of drugs. The grain,

the gram and the *roentgen* are all exact physical units of measure.

## CONCLUSIONS

1. On account of the variation in skin manifestations, the reaction of the human skin cannot be used as a standard for comparison of physical factors.

2. A unit of erythema cannot be divided to determine biological reactions nor can a unit erythema dose be used as a standard to indicate the response to a treatment which is not given at a single sitting.

3. The reaction of pathological tissues to radiation cannot be determined on the basis of a reaction of the normal skin.

4. There is no satisfactory biological standard for the determination of radiation intensities.

5. The only skin effect which is of importance is the average skin tolerance limit.

6. The direct method of measuring applied intensities is preferable.

7. The roentgen (r) is a practical physical unit of measure of applied intensity.

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# THE EFFECT OF HIGH VOLTAGE ROENTGEN RADIATION (200 kv.) UPON THE FERTILITY AND MOTILITY OF THE SPERM OF THE RABBIT*

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LITTLE has been done to investigate the effects of deep roentgen therapy upon fully developed, adult spermatozoa. We have attempted to study the changes brought about in the sperm by all of the wave lengths in an unfiltered beam of roentgen rays produced at 200 kv. (deep therapy) by noting the effect upon the animals using, in general, long or medium wave lengths of roentgen rays. The consensus of opinion has been that irradiation with the longer wave lengths does not affect the adult structures of the testis but only the immature or embryonic cells. If the testes are irradiated, sterility occurs only after a latent period. This period is apparently the time necessary for the maturation of the immature cells of the generation succeeding the adult sperm present during the irradiation, and sterility has its onset from their failure in development or from the gradual loss and destruction of the adult sperm already fully developed.

TABLE I

FERTILITY STUDY OF IRRADIATED AND UNIRRADIATED RABBIT SPERM

| Rabbit | Number | Dosage* | Condition of Sperm | Results |
|---|---|---|---|---|
| Control | R 6 | 5 E.D. | All sperm non-motile after end of irradiation—8 min. | No litters |
| | R 9 | | | |
| Irradiated | R 8 | | | |
| | R 20 | | | |
| Control | R 1 | 3.5 E.D. | All sperm alive before irradiation started, and all sperm non-motile at insemination. Irradiation for 10 minutes. | No litters |
| Irradiated | R 11 | | | |
| | R 18 | | | |
| Control | R 10 | 3.5 E.D. | Inseminated with active sperm | No litters |
| | R 15 | | " " " " | Small litter (4) |
| | R A | | " " " " | Small litter (3) |
| Irradiated | R 6 | | " " " " | No litter |
| | R 9 | | " " " " | Small litter (2) |
| | R B | | " " " " | No litter |
| | R C | | " " " " | No litter |
| Irradiated | R 16 | 11 E.D. | Inseminated with active sperm | Small litter (3) (died next A.M.) |
| | R 17 | | | |

* 200 kv., 1 cm. wood, 55 cm. target-dish distance, water-cooled Coolidge tube.

fertility and motility. The study of fertility was attempted through artificial insemination of irradiated spermatozoa by a method developed in a study of artificial insemination and fertility by one of us in a previous work.[2]

The work of Regaud, Bagg, and others[1] on the testis has been done upon living

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METHOD

Twenty-two full grown female rabbits were used in these experiments. It has been found that ovulation in rabbits occurs about ten hours after copulation.[2] For fertility studies, does were allowed to copulate with vasectomized bucks. One hour later, these does were artificially inseminated with irradiated or control spermatozoa. The does were then set aside in single cages to await the development of pregnancy. Sperm for artificial insemination and for the motility experiments was obtained by sacrificing, with a sharp blow on the head, a doe which had just copulated with one or more vigorous normal bucks. The abdomen was immediately opened and the genital tract freed by blunt dissection. The lower vagina was plugged or clamped shut to prevent extrusion of the semen by contraction and also to prevent contamination with urine. The latter almost always occurs if this precaution is not observed. Four or 5 c.c. of Ringer's solution was added to the semen in the vagina to make it somewhat less viscous. The semen was removed by a syringe inserted through the wall of the vagina. Every

TABLE II

MOTILITY STUDY OF IRRADIATED AND UNIRRADIATED RABBIT SPERM

SUMMARY

| Total Time of Observation min. | Total Irradiation | State and Duration of Motility | | Filter | Voltage kv. | Remarks |
|---|---|---|---|---|---|---|
| | | Control | Irradiated | | | |
| 15 | 250 ma-min.<br>5 E.D. | None | None | 1 cm. wood | 200 | Poor specimen |
| 15 | 112 ma-min.<br>3+ E.D. | Non-motile in 15 min. | Non-motile in 15 min. | 1 cm. wood | 198 | Poor specimen |
| 8 | 200 ma-min.<br>6+ E.D. | Non-motile; 8 min. | Non-motile; 8 min. | 1 cm. wood | 200 | Poor specimen |
| 46 | 350 ma-min.<br>1 E.D. | Fair vigor at finish; 46 min. | Fair vigor at finish; 46 min. | 1.0 mm. Al<br>0.5 mm. Cu | 200 | Good specimen |
| 96 | 300 ma-min.<br>9+ E.D. | Feeble; 96 min. | Very feeble; 96 min. | 1 cm. wood | 200 | Good specimen |
| 35 | 112 ma-min.<br>3+ E.D. | Motile; 35 min. | Non-motile (cold); 35 min. | 1 cm. wood | 200 | Good specimen |
| 10 | 125 ma-min.<br>3.5 E.D. | Motile; 10 min. | Motile; 10 min. | 1 cm. wood | 200 | Good specimen |
| 26 | 367 ma-min.<br>11 E.D. | Very active; 30 min. | Very active; 30 min. | 1 cm. wood | 200 | Good specimen |
| 60 | 750 ma-min.<br>7 E.D. | Fairly active; 60 min. | Fairly active; 60 min. | 1 cm. wood | 100 | Good specimen |
| 57 | 700 ma-min.<br>2 E.D. | Fairly motile; 57 min. | Fairly active; 57 min. | 0.5 cm. Cu<br>1.0 mm. Al<br>1.0 cm. wood | 193–200 | Good specimen |

attempt was made to obtain the material in its original state, uncontaminated by urine, dirt, or too much Ringer's solution.

The material obtained was immediately mixed, divided into two equal portions, and placed in two small covered glass petri dishes and kept warm. One portion was used as the control while the other was placed upon the deep therapy couch and exposed to radiation at a distance of 58 cm. be ensured by a copulation with a vasectomized buck at or a little previous to the time of artificial insemination. Otherwise small litters or sterility results.

The first two groups of does composed of 3 controls inseminated with unirradiated sperm and 4 with irradiated sperm bore no litters (Table 1). In all these cases, the sperm were not motile when examined just prior to insemination so this result is not

Table III

DETAIL OF MOTILITY EXPERIMENTS IN MINUTES

| Experiment | Copulation to Irradiation | Specimen | Time | | | | | | | | | | | | | | Dosage | Voltage | Filter |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | 5 | 10 | 15 | 20 | 22 | 24 | 26 | 28 | 31 | 34 | 37 | 40 | 43 | 46 | | | |
| | 17 min. | Control | *** | *** | *** | *** | o | *** | *** | * | * | ** | ** | *– | ** | ** | 350 ma-min. 1 E. D. | 200 kv. | 1.0 mm. Al 0.5 mm. Cu |
| | | Irradiated | *** | *** | *** | *** | o | *** | *** | *** | *– | ** | ** | ** | ** | ** | | | |
| 2 | | | 3 | 6 | 9 | 12 | 15 | 16 | 18 | 20 | 23 | 26 | 28 | 30 | 66 | 96 | | | |
| | 23 min. | Control | ** | *** | *** | *** | ** | ** | ** | ** | ** | ** | ** | *– | *– | dead | 300 ma-min. 9 E. D. | 200 kv. | 1 cm. wood |
| | | Irradiated | ** | ** | ** | ** | * | * | ** | *– | *– | *– | *– | *– | *– | *– | | | |
| #3 | | | 6 | 10 | 14 | 35 | 45 | 55 | 60 | | | | | | | | | | |
| | 19 min. | Control | *** | **** | **** | *** | *** | *** | *** | | | | | | | | 18 E. D. | 100 and 200 kv. | 1 cm. wood |
| | | Irradiated | *** | **** | **** | *** | *** | *** | *** | | | | | | | | | | |
| ##4 | | | 7 | 14 | 21 | 41 | | | | | | | | | | | | | |
| | 25 min. | Control | **** | *** | *** | ** | | | | | | | | | | | 700 ma-min. 2 E. D. | 200 kv. | 0.5 mm. Cu 1.0 mm. Al 1.0 cm. wood |
| | | Irradiated | **** | **** | **** | ** | | | | | | | | | | | | | |

# Good conditions—both specimens equally motile at finish.
## Good conditions—both specimens identical in appearance at finish.

Motility very active **** good *** fair ** poor * feeble *– none o

from the target. At suitable intervals sample drops of both the irradiated and control specimens were examined for motility under the low power field of the microscope. At the termination of the irradiation, does previously prepared for ovulation by copulation with vasectomized bucks were artificially inseminated with the irradiated and control specimens.

## DISCUSSION

In experiments involving the artificial insemination of rabbits, the time element is exceedingly important. Ovulation must

surprising. Although every precaution had been taken, the sperm had apparently perished. In a further group of 3 controls, 2 had small litters, and 2 out of 5 inseminated with irradiated sperm had small litters. Although the number of cases is few, it is suggested that, following irradiation of the type and amount used, little or no effect upon the fertility of the adult spermatozoa is to be observed. In view of the relatively enormous dosage, the deleterious effect on the sperm should have been pronounced. We regard it as established that radiation of the type used in

sterilization practice is unlikely to injure the sperm already formed to such an extent as to impair their fertilizing power to any marked degree. No monstrosities or defects were noted in any of the young. In general, this failure to affect adult sperm agrees with the work of others (Warren[1]) using long wave lengths of roentgen rays upon the testes. Because of this agreement and the difficulties of the procedure, further experimentation in this direction did not seem warranted.

The motility of rabbit sperm irradiated for a prolonged time was next studied at some length (Table II). After varying amounts of unfiltered and heavily filtered radiation had been used, no definite effect from the irradiation could be observed. It is evident that massive doses of roentgen rays have no immediate effect on the motility of spermatozoa.

## SUMMARY AND CONCLUSION

Rabbit spermatozoa were placed in a thin petri dish and were given huge amounts of radiation consisting of all the wave lengths in unfiltered and filtered beams of radiation produced at 100 to 200 kilovolts. Motility studies of the sperm during these experiments gave no indication of any change resulting from the irradiation. Two litters of apparently normal young were obtained by artificial insemination with irradiated sperm.

Thus no immediate or latent effects are produced in sperm by huge amounts (many erythema doses) of unfiltered or filtered radiation from the long to the very short (200 kv.) roentgen radiation.

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# MENISCUS CALCIFICATION

## ROENTGEN FINDINGS IN DISEASE OF THE MENISCI*

*By* MARTIN ISRAELSKI, M.D.
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VERY little is known of the roentgen findings in disease of the menisci. An asymmetrical appearance of the knee-joint after trauma not involving the bone may be construed as a fracture or dislocation of a meniscus. But apart from that, roentgen examination of the knee-joint is usually negative in accident cases.

I wish to draw attention to a pathological condition of the menisci which can be recognized roentgenologically before it has produced noticeable impairment of joint movements, namely, the occurrence of deposits of calcium salts in the menisci. Mandl and others have reported the occasional occurrence of microscopic calcium deposits in necrotic areas of diseased menisci. In the literature only 3 cases of calcification of the menisci which have been recognized roentgenologically have been reported, and recently 3 other cases have been reported by Pollack and myself.[1]

FIGS. 1 and 2. Anteroposterior and lateral views of the left knee-joint of stone-mason, aged sixty, showing calcification of the menisci.

In the so-called "primary meniscopathies" the roentgen findings are also usually negative. In this condition there is found a chronic degeneration of the meniscus cartilage, largely due to the increased strain thrown on the knee-joint, and occurring mostly in those actively engaged in sport. This may produce a clinical picture similar to meniscus injury, but none the less no such trauma is present.

The roentgenograms here reproduced

[1] Israelski, M., and Pollack, H. Ueber Kalkablagerungen in den Knieegelenken und Intervertebralscheiben. *Beitr. z. klin. Chir.*, Sept., 1930, *150*.

* From the X-ray Department of the Städtisches Krankenhaus am Urban, Berlin.

(Figs. 1 and 2) are from the left knee-joint of a patient who showed the most pronounced calcification on both knees yet reported. Here the tibiofemoral space is normal in outline and of equal breadth throughout and the articular surfaces of the femur and tibia are intact. But one sees diffuse calcified deposits occupying the position of the menisci, with smaller patches and lines of deposit lying outside these. A

FIG. 3. Lumbar vertebrae of gardener, aged sixty-five, showing calcification of the peripheral parts of the intervertebral discs.

narrow band of calcium lying parallel to the articular surface of the femur is particularly well marked. This is apparently an incrustation of calcium on the surface of the articular cartilage of the femur. The large arteries around the joint are seen to be calcified. The right knee-joint showed similar changes. The patient was a stonemason, aged sixty, who had suffered from diabetes for the last three years. In bad weather he complained of drawing pains and a certain amount of stiffness in the knees. On examination the knee-joint showed no abnormal features, except for the presence of a fairly coarse crepitus, but there was no limitation of movement. There was no necessity to undertake any treatment for the knees, as the patient was incapacitated for work by his diabetes. There has been no subjective or objective change in the joint condition for the last year.

In the other cases the calcification was mostly limited to the menisci, and in some only one meniscus was affected in the knee-joint.

Judging from the cases which have so far been described, one can draw the following conclusions concerning calcification of the menisci. The affection has its onset past middle life (over forty-five), is usually bilateral, and has generally no relation to trauma. Arthritis deformans is usually not

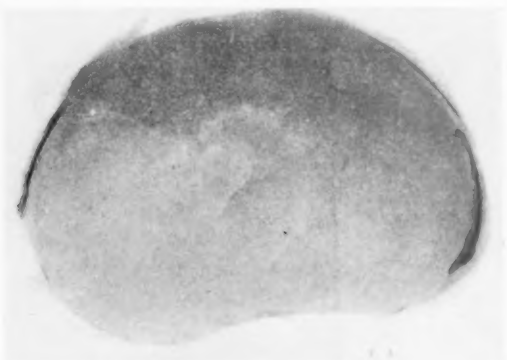

FIG. 4. Isolated intervertebral disc of same patient as in Figure 3, roentgenographed post mortem, showing calcification around the edges.

present. The calcification can occur without causing the patient any discomfort. Should pain in the joints occur—possibly as the result of some slight injury—then such therapeutic measures as rest, heat and hydrotherapy are usually sufficient to allay the discomfort. As a rule, there is no indication for any surgical procedure, such as removal of the meniscus. In only one case was operation undertaken, and the meniscus examined histologically; it showed a depletion of cartilage cells, a predominance of fibrous tissue and a diffuse infiltration with calcium. With regard to the etiology,

it appears that apart from local factors, metabolic disturbances play a part. Thus one of our cases had diabetes, another gout. It is also of interest that in our 3 cases, apart from the meniscus calcification, there were also found areas of calcification in the peripheral parts of the intervertebral discs. Figure 3 shows a roentgenogram of the lumbar vertebrae of one of the patients, a gardener aged sixty-five, who complained of very slight pains in the back. The peripheral parts of the intervertebral discs show calcified shadows, some semicircular, others disc-like, which are separated from the vertebrae by a clear space. The patient died as the result of carcinoma of the sigmoid, and the intervertebral discs were removed and roentgenographed. Figure 4 shows the isolated intervertebral disc between the second and third lumbar vertebrae. Just inside the lateral edges of the disc there are lines of calcium deposit which run circumferentially parallel to the edge. On microscopic examination there were found areas of necrosis, some of which were infiltrated with calcium deposits. Roentgenological investigation of a series of the vertebral columns of cadavers showed that some linear or patchy calcified areas in the periphery of the intervertebral discs are fairly frequent in persons over sixty. None the less, the finding here reported is very uncommon, particularly as it was demonstrated during life. The clinical importance of the calcified areas in the periphery of intervertebral discs is apparently small.

The simultaneous occurrence of calcification in the menisci and intervertebral discs, both tissues containing elastic fibrocartilage, makes it likely that one of the factors responsible for this condition is a tendency for the degeneration or necrosis of the fibrocartilage and its impregnation with calcium.

# TUBERCULOUS ULCERATION OF THE DUODENUM*

## CASE REPORT

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TUBERCULOUS ulceration of the intestine is a common complication of pulmonary tuberculosis but it is seldom met with as a primary disease. Evidence of tubercle bacilli having entered the gastrointestinal tract without pulmonary involvement is frequently found,[4] and Fenwick and Dodwell[3] state without giving case reports that the occurrence is not uncommon in children. In the latters' series of 2000 necropsies of patients with pulmonary tuberculosis, 500 cases showed evidence of tuberculous disease of the intestine. Of this number, only 3.4 per cent showed evidence of secondary lesions in the duodenum. They found the tuberculous lesion usually situated in the lower portion of the duodenum, below the site of simple ulcer.

Rintel and Schultzen,[7] in 1867, reported the case of a child, aged three and a half years, in whom a primary ulceration, found in the duodenum at necropsy, had perforated and extended into the cecum. No evidence of tuberculosis was found elsewhere.

Moynihan,[6] in 1912, discussed the cases reported in the literature and described the primary and secondary lesions in the duodenum. He gave no specific case reports, however, in which primary ulceration was found.

Buckley,[2] in 1927, gave a very complete case report with post-mortem findings. Probably Brown and Sampson[1] have made the most complete study of intestinal tuberculosis.

Röpke,[8] in 1928, reported 2360 necropsies of tuberculous patients and found 18 with stomach involvement and 5 with lesions in the duodenum. He quotes Ricard and Chevrier as having found 107 cases of tuberculosis of the stomach and only 10 where the duodenum alone was involved.

### PATHOLOGY

Tuberculous ulcers differ in gross appearance from simple ulcer in that the edges are scalloped, very irregular, undermined and elevated. Tubercles are seen in the thickened wall. Recent ulcers may have diffusely caseous bases or there may be gray and yellow nodules which on section are seen to extend into the muscularis. Isolated polypoid islands of mucosa may persist in the midst of very large ulcers. Tubercles are seen frequently on the serosa over the ulcer as dark blue-gray vascular dots or as finely villous proliferations covered with vessels. The tubercles follow the lymphatics like a rosary or string of

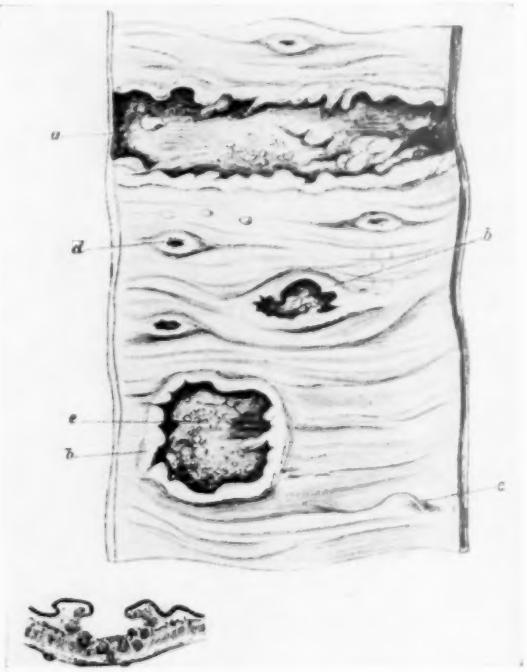


FIG. 1. Tuberculous ulceration of bowel: *a*, older annular ulcer; *b* and *d*, early stages, elevated, undermined, irregular margins; *c*, tubercles beneath the mucosa; *e*, tubercles projecting from the floor of the ulceration. (From Kaufmann.)

* From the Medical Department, Columbia University College of Physicians and Surgeons and the Roentgen Ray Department of the Presbyterian Hospital, New York City.

pearls, or in stellate figures along the long axis of the bowel. Others extend across the bowel toward the mesentery where they may be followed to a lymph node[5] (Fig. 1).

Microscopically, characteristic tubercles with epithelioid and giant cells are found in the freshly swollen follicles, and tubercle bacilli can be found in the very beginning of these changes (Kaufmann). The first changes are miliary or sub-miliary tubercles, isolated or in groups in the mucosa, submucosa or muscularis, and they may also be found in the margins of the ulcer.

### SYMPTOMS

Because of a complete absence of symptoms, tuberculous ulceration of the intestines is more frequently recognized at autopsy than during life.[9]

### CASE REPORT

A. S. (Unit No. 197674), a single, Irish, lady's maid, aged thirty-seven, came to the Vanderbilt Clinic, Feb. 19, 1929, complaining of pain in the right side and an afternoon temperature, of seven weeks' duration. She had been well until two years previously when she began having a dull, aching pain in the right side. At that time, she was operated upon for appendicitis without relief of symptoms. The pain was of a dull dragging nature, more marked in the right upper quadrant and at times relieved by food or soda. Tarry stools were noticed at irregular intervals. Seven weeks prior to her visit to the clinic, she developed a cold followed by an antral infection. A week later, she vomited a dark brown material and for two weeks noticed tarry stools. The pain was relieved by food until two weeks prior to her visit, at which time it became more severe.

A cholecystogram was made on Feb. 20, and the gall-bladder appeared of normal density and contracted under stimulus of fat.

Roentgen examination of the gastrointestinal tract, March 19, disclosed a hypotonic stomach which contained a large, probably 50 per cent, residue. The duodenal bulb was persistently deformed and tender to palpation.

She was given a Sippy regime and when seen in April was much better, but still complained of a dull aching, non-radiating pain in the right upper abdomen. The symptoms continued and on Aug. 21, a second cholecystogram disclosed a very faint gall-bladder shadow which did not contract under the stimulus of fat. A diagnosis of cholecystitis was made.

She was admitted to the Hospital, Dec. 10, 1929. The temperature on admission was 97° F.

Physical examination was essentially negative except for marked obesity and the vague tenderness in the right upper abdomen.

Operation, Dec. 13, by Dr. F. B. St. John, disclosed a moderately thickened gall-bladder and a scarred area in the duodenal bulb. The gall-bladder was removed and the scarred area excised.

The microscopical examination of the section from the duodenum disclosed a small group of definite tubercles in the mucous membrane which were made up of epithelial and giant cells without central necrosis and with very few lymphocytes.

Examination of sections of the gall-bladder showed lymphocytic and leucocytic infiltration of the submucosa and muscularis. A diagnosis of chronic cholecystitis was made.

The patient made an uneventful recovery and went home in the fourth week. When last seen, March 11, 1930, she had no complaints and looked very well.

### COMMENT

The deformity produced by tuberculous ulceration closely resembles that of simple ulcer. The ulcers often appear in the second portion of the duodenum, below the usual site of simple ulcer.

No definite cases are recorded in the literature where the lesion was discovered by means of the roentgen examination. This case is of special interest because of the coincident gall-bladder disease. The symptoms in this case might have been due to the gall-bladder.

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# DWARFISM DUE TO DISORDERED EPIPHYSEAL DEVELOPMENT

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SINCE 1918 we have encountered 8 cases of a peculiar form of dwarfism, described by Morquio in 1929. His paper is the only presentation of the condition I have been able to find. He reported 4 children affected out of a family of 5, the other being a mental defective. We have one family of 7 children, the oldest, the fourth and the seventh showing this deformity. In another family 2 children are affected, and a third child died at three weeks, a blue baby. One boy patient of ours has 2 normal brothers. One girl has a sister and 2 brothers who are normal. The parents of Morquio's cases were cousins and the paternal grandparents were cousins. Our cases had nothing significant in the family history.

The appearance of these patients is characteristic. They look like members of the same family. Photographs of Morquio's cases are very similar to ours. These children are short and do not often exceed 1 meter in height. The head is large. Eyes are widely spaced. The root of the nose is somewhat depressed. The sternum is narrow and prominent. There is apt to be a kyphosis in the thoracic or lumbar region. The hips are somewhat flexed. The hands reach almost to the knees. There is a marked genu valgum and the feet are held 10 to 15 cm. apart. The epiphyseal ends of the long bones are prominent. The wrists and ankles show considerable hypermobility. There is a characteristic loss of power in the arms and legs but no muscular atrophy. The hair is fine. The skin is dry and coarse. The intelligence is usually unimpaired. However, 2 of the 3 patients in the family first mentioned are deaf and mentally defective, with cloudy corneas. The condition is congenital and early signs of it are apparent at two to three months. In some cases they are overlooked until the child begins to walk.

The laboratory findings, including Wassermann, blood sugar, calcium and phosphorus, are negative. The basal metabolic rate may be plus 10 to 20 per cent.

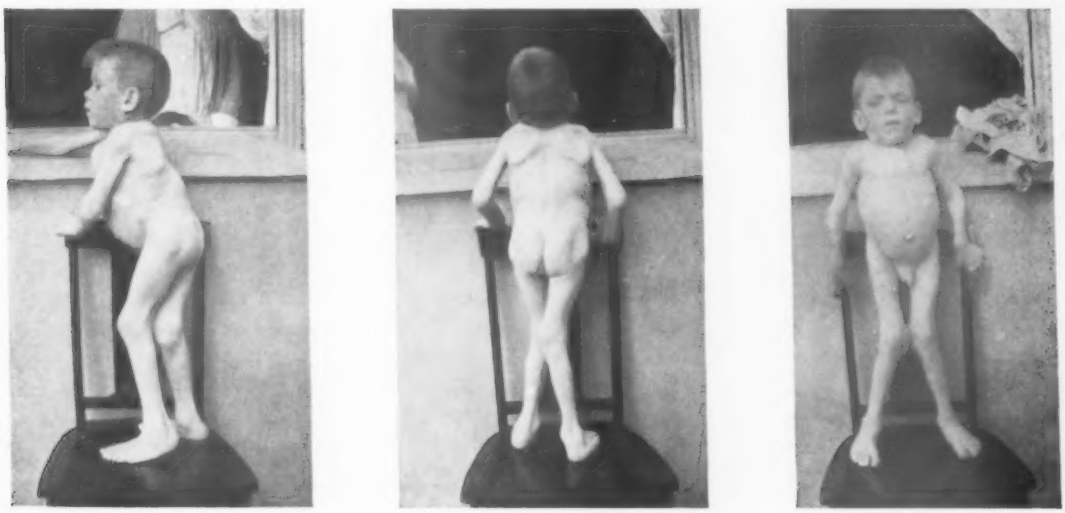

FIG. 1. Earl B, aged eight years.

FIG. 2. Frances B., aged thirteen years.

The roentgen findings are as characteristic as the outward appearance. Films of any of the children of approximately the same age are almost identical. The oldest patient in our series is over twenty-two and shows about the same roentgen appearance as other children of ten to fifteen.

The process is due to a profound disturb-

FIG. 3. Merton W., aged seven years. Eight years after this film there was no change in the epiphyses or ossification centers and no new centers had appeared, although the child had been on thyroid medication for a prolonged period.

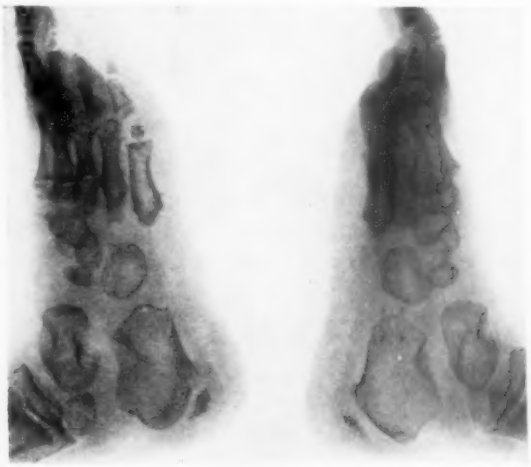

FIG. 4. Phyllis W., aged eleven years.

ance of epiphyseal development, as the illustrations show. The calvarium is negative. The sella turcica may be small, with heavy clinoid processes. The ribs are heavy and expanded at the costal cartilages. The bases of the metacarpals are pointed. Ossification begins in the distal row of carpal bones and they are always small and irregular in outline. The epiphyseal zones of the radius and ulna are rotated toward each other to a marked degree. The heads of the femurs are usually absent.

Fig. 5. Merton W., aged fifteen years. The only change during the past eight years has been a slight increase in the erosion of the outer condyles of the tibiae.

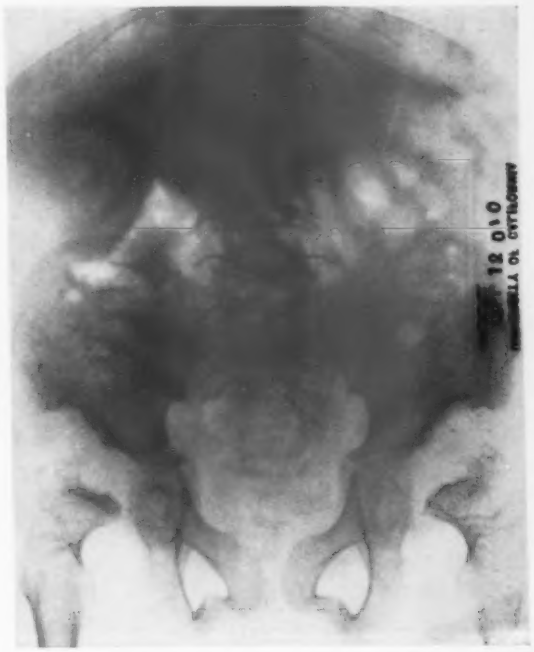

Fig. 6. Merton W., aged fifteen years, showing characteristic changes in the hip-joints and lumbar vertebrae.

Fig. 7. Charlotte R., aged six years.

Fig. 8. Merton W., aged fifteen. Showing the irregularity in outline characteristic of the small bones, vertebral bodies and epiphyses.

The acetabula are eroded upward and are irregular in outline. The knees show a marked loss of substance of the outer condyles of the tibiae and an overgrowth of the inner condyles of the femurs, accounting for the striking genu valgum. There is a relative shortening of the fibulae so that the heads lie considerably below their normal position. The feet show fairly well-developed tarsal bones which are extremely irregular in outline, and the bases of the metatarsals are pointed. The vertebral bodies are wide and flat, some of them pointed anteriorly, others short and wedge-shaped, where a kyphos is present. The intervertebral discs are as thick as the bodies. All the bodies show ragged outlines.

Achondroplasia is the disease most resembling this condition. In achondroplasia the epiphyses close early; the zones are narrow. Otherwise, the epiphyseal development proceeds in a fairly normal manner. The heads of the fibulae usually reach higher than normal and these individuals possess a powerful musculature. Epiphyseal dystrophy shows the characteristic disturbance of epiphyseal development, short fibulae and loss of muscular power.

Treatment with thyroid, pituitary and other extracts has been without results.

Determination of the etiology of the condition waits upon a careful autopsy of one of these unfortunate youngsters. Such an investigation should throw considerable light upon factors governing epiphyseal development.

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*Delegate to Third International Congress, Paris, July 27–31, 1931:* P. M. Hickey, Ann Arbor, Mich.; Alternate, G. E. Pfahler, Philadelphia, Pa.

*Editor:* Lawrence Reynolds, 110 Professional Building, Detroit, Mich.

*Editorial Board:* A. C. Christie, E. H. Skinner, Wm. Duane.

*Advisory Board for Pathology:* James Ewing, Eugene Opie, Aldred S. Warthin.

*Publisher:* Charles C. Thomas, 220 East Monroe St., Springfield, Ill.

*Thirty-second Annual Meeting:* Atlantic City, N. J., September, 1931.

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*Sixteenth Annual Meeting:* Philadelphia, 1931.

*Committee on Arrangements:* G. E. Pfahler, Chairman, 1321 Spruce St., Philadelphia, W. S. Newcomet, Philadelphia, W. H. Schmidt, Philadelphia, W. L. Clark, Philadelphia, W. H Kraemer, Philadelphia.

# EDITORIAL

## A ROENTGEN SIGN IN LEAD POISONING

LEAD poisoning is not an infrequent occurrence and its recognition unless the history of the patient is obtained may at times be fraught with some difficulty. As is well known, lead intoxication is one of the most common poisonings in industry and is also occasioned by such non-industrial sources as water supplies, cosmetics, drugs and home-made beverages. Lead poisoning occurs occasionally in children as the result of gnawing the enamel on the bed or from toys or from lead nipple shields which mothers sometimes use, and these are frequently the sources of lead poisoning in children which may go unrecognized.

Apparently heretofore the roentgen rays have not been used in the diagnosis of lead poisoning except in observations on the gastrointestinal tract in the presence of lead colic. However, Vogt[1] in a recent article has called attention to a roentgen sign of plumbism wherein the roentgenograms of the extremities of infants in whom lead poisoning was suspected showed a marked flaring of the ends of the long bones with an unusually dense zone at the ends of the diaphyses. The question arose as to whether this density was due to healed rickets alone or whether lead poisoning was in part accountable. This stimulated a further search among the records of the Children's Hospital, and coming upon several cases which had been clinically diagnosed as lead poisoning, they discovered that these cases also showed this unusually dense zone at the ends of the diaphyses which had been previously overlooked or had been interpreted as probably indicating healed rickets. One of their cases was an infant girl seven months of age who was taken to the hospital with the chief symptom of vomiting for three weeks. Nothing unusual was revealed on physical examination but many stippled cells were found in the blood smear. The roentgenograms showed a very dense band at the ends of the long bones, which when considered with the clinical picture was obviously due to lead poisoning. The patient died while in the hospital and an autopsy was obtained. A chemical analysis of the right femur showed the zones of greatest density on the roentgenograms to contain less calcium but four times as much lead as the cortex. Therefore it seemed evident that the opacity of the diaphyseal ends of the bones was due to a deposit of lead. This is not surprising in the light of the work of Aub and his coworkers[2] in their study of calcium and lead metabolism showing that the storage of lead takes place in those portions of the skeleton where calcium deposit is most evident, namely, in the growing ends of the bones. This roentgen sign of plumbism is of considerable importance as not infrequently in the widespread use of the roentgen rays in the examination to determine the presence or absence of rickets occasional cases of lead poisoning might be encountered. As Vogt points out, a differentiation between the heavy dense line of plumbism and healed rickets and the condition of so-called marble bones must be considered. However, the zone of density of the diaphyseal ends of the bones in plumbism is a great deal heavier than that seen in healed rickets and as so-called marble bones is a relatively infrequent occurrence it should cause little confusion in differential diagnosis.

[1] Vogt, E. C. A roentgen sign of plumbism; the lead line in the growing bone. AM. J. ROENTGENOL. & RAD. THERAPY, Nov., 1930, 24, 550-553.

[2] Aub, J. C., et Al. Lead Poisoning. Medicine Monographs. Vol. VII. Williams and Wilkins Co., Baltimore, 1925.

# SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

*Items for this section solicited promptly after the events to which they refer.*

## MEETINGS OF ROENTGEN SOCIETIES*

### United States of America

American Roentgen Ray Society
*Secretary*, Dr. John T. Murphy, 421 Michigan St., Toledo, Ohio.
Thirty-second annual meeting: Atlantic City, N. J., 1931.

American College of Radiology
*Secretary*, Dr. Albert Soiland, 1407 S. Hope St., Los Angeles, Calif.
Annual Meeting: Philadelphia, 1931.

Section on Radiology, American Medical Association
*Secretary*, Dr. G. W. Grier, Jenkins Arcade, Pittsburgh, Pa.
Annual meeting: Philadelphia, June 8–12, 1931.

Radiological Society of North America
*Secretary*, Dr. I. S. Trostler, 812 Marshall Field Annex, Chicago, Ill.
Seventeenth annual session: to be announced.

Radiological Section, Los Angeles County Medical Society
*Secretary*, Dr. Orville N. Meland, 1407 S. Hope St., Los Angeles.
Meets on the third Wednesday of each month at the California Hospital.

Radiological Section, Southern Medical Association
*Secretary*, Dr. W. S. Lawrence, Medical Arts Bldg., Memphis, Tenn.

Brooklyn Roentgen Ray Society
Secretary, Dr. J. J. Masterson, 401-76th St., Brooklyn, N.Y.
Meets monthly on the first Tuesday from October to April.

Buffalo Radiological Society
*Secretary-Treasurer*, Dr. Joseph S. Gian-Franceschi, 610 Niagara St.
Meets second Monday of each month except during the summer months, the place of meeting to be selected by the host.

Chicago Roentgen Society
*Secretary*, Dr. George M. Landau, 660 Groveland Park.
Meeting second Thursday of each month October to May inclusive at Virginia Hotel.

Cleveland Radiological Society
*Secretary*, Dr. A. Srauss, 518 Medical Arts Bldg.
Meetings are held at 6:15 P.M. at the Cleveland Chamber of Commerce Club rooms on the fourth Monday of each month from October to April, inclusive.

Detroit Roentgen Ray and Radium Society
*Secretary*, Dr. E. R. Witwer, Harper Hospital.
Meets monthly on first Thursday from October to May, at Wayne County Medical Society Building.

Central Illinois Radiological Society
*Secretary*, Dr. H. C. Kariher, Decatur, Illinois.
Regular meetings held quarterly.

Indiana Roentgen Society
*Secretary*, Dr. J. N. Collins, Indianapolis, Ind.
Annual meeting each February 22 in Indianapolis.

Milwaukee Roentgen Ray Society
*Secretary*, Dr. J. E. Habbe, 221 Wisconsin Ave., Milwaukee.
Meets first Friday in October, December, February and April.
Place of meeting designated by the president.

Minnesota Radiological Society
*Secretary*, Dr. L. G. Rigler, University Hospital, Minneapolis, Minn.
Next meeting, to be announced.

New England Roentgen Ray Society
*Secretary*, Dr. Thomas R. Healy, 370 Marlboro St., Boston, Mass.
Meets monthly on third Friday, Boston Medical Library.

New York Roentgen Society
*Secretary*, Dr. J. Bennett Edwards, Englewood Hospital, Englewood, N. J.
Meets monthly on third Monday, New York Academy of Medicine, at 8:30 P.M.

Central New York Roentgen Ray Society
*Secretary*, Dr. D. S. Childs, 316 Gurney Bldg., Syracuse, N. Y.
Three meetings a year—April, August and November.

Pennsylvania Radiological Society
*Secretary*, Dr. W. E. Reiley, Clearfield, Penna.
Next meeting, Penn. McKee Hotel, McKeesport, Pa., May 13–14, 1931.

Philadelphia Roentgen Ray Society
*Secretary*, Dr. Karl Kornblum, 3400 Spruce St.
Meeting first Thursday of each month from October to May inclusive, at 8:15 p.m., in Thomson Hall, College of Physicians, 19 S. 22d St.

Rochester Roentgen Ray Society, Rochester, N. Y.
*Secretary*, Dr. Camp C. Thomas, 476 Lake Ave.
Meets monthly on the first Friday evening at 7:45 at the Rochester Medical Association Building.

St. Louis Roentgen Club
*Secretary-Treasurer*, Dr. L. R. Sante, Missouri Building.
Meets first week of each month. Time and place of meetings designated by president.

Texas Radiological Society
*Secretary-Treasurer*, Dr. C. P. Harris, Houston, Texas.
Meets annually one day preceding the meeting of the Texas State Medical Association.

University of Michigan Roentgen Ray Society
*Secretary*, Dr. D. M. Clark, University Hospital, Ann Arbor, Mich.
Meets every Wednesday evening from September to July, at 7:30 o'clock in the amphitheatre of the University Hospital.

* Secretaries of societies not here listed are requested to send the necessary information to the Editor.

VIRGINIA ROENTGEN RAY CLUB
*Secretary*, Dr. Wright Clarkson, 205 S. Sycamore St., Petersburg, Va.
Next meeting, to be announced.

CUBA

SOCIEDAD CUBANA DE RADIOLOGIA Y FISIOTERAPIA
*Secretary*, Dr. Francisco Padron, Enrique Villuendas 64, Havana, Cuba. Meets monthly in Havana.

BRITISH EMPIRE

BRITISH INSTITUTE OF RADIOLOGY INCORPORATED WITH THE RÖNTGEN SOCIETY
Meets on the third Thursday of each month, from November to June inclusive, at 8:15 P.M., at 32 Welbeck St., London, W. 1., or as advertised.

ELECTRO-THERAPEUTIC SECTION OF THE ROYAL SOCIETY OF MEDICINE (CONFINED TO MEDICAL MEMBERS)
Meets on the third Friday of each month during the winter at 8:30 P.M. at the Royal Society of Medicine, 1 Wimpole St., London, W. 1.

SECTION OF RADIOLOGY AND MEDICAL ELECTRICITY, AUSTRALASIAN MEDICAL CONGRESS
*Secretary*, Dr. H. M. Cutler, 139 Macquarie St., Sydney, New South Wales.

RADIOLOGICAL SECTION OF THE VICTORIAN BRANCH OF THE BRITISH MEDICAL ASSOCIATION
*Secretary*, Dr. Colin Macdonald, Lister House, 61 Collins St., Melbourne, Australia.
Meets monthly at Melbourne during the winter.

SECTION ON RADIOLOGY, CANADIAN MEDICAL ASSOCIATION
*Secretary*, Dr. A. H. Rolph, 160 St. George St., Toronto, Ont.

RADIOLOGICAL SECTION, NEW ZEALAND BRITISH MEDICAL ASSOCIATION
*Secretary*, Dr. P. C. Fenwick, The Hospital, Christchurch.
Meets annually.

CONTINENTAL EUROPE

BELGIAN SOCIETY OF ROENTGENOLOGY
*Secretary*, Dr. J. Boine, Avenue des Alliés, 134, Louvain (Belgium).
Meets monthly on second Sunday at d'Egmonds Palace, Brussels, except in the summertime.

SOCIETE DE RADIOLOGIE MÉDICALE DE FRANCE
Meets monthly on second Tuesday, except during months of August and September, 12 Rue de Seine, Paris.

SOCIÉTÉ SUISSE DE RADIOLOGIE (SCHWEIZERISCHE RÖNTGEN-GESELLSCHAFT)
Secretary for French language, Dr. A. Grosjean, La Chaux de Fonds.
Secretary for German language, Dr. Scheurer, Molzgasse, Biel.
Meets annually in different cities.

SOCIÉTÉ FRANCAISE D'ELECTROTHÉRAPIE ET DE RADIOLOGIE MÉDICALE.
Meets monthly on fourth Tuesday, except during months of August and September, 12 Rue de Seine, Paris.

ASSOCIATION OF GERMAN ROENTGENOLOGISTS AND RADIOLOGISTS IN CZECHO-SLOVAKIA
*Secretary*, Dr. Walter Altschul, German University, Prague, II/52.

DEUTSCHE RÖNTGEN-GESELLSCHAFT (GESELLSCHAFT FÜR RÖNTGENKUNDE UND STRAHLENFORSCHUNG)
Meets annually in April, alternating one year in Berlin, one year in some other German city. Meets in addition every two years with the Gesellschaft deutscher Naturforscher und Aerzte.
*Permanent secretary*, Professor Dr. Haenisch, Klopstockstrasse 10, Hamburg, Germany.

SÜD- UND WESTDEUTSCHE RÖNTGENGESELLSCHAFT
Meets annually in different cities.

NORD- UND OSTDEUTSCHE ROENTGENGESELLSCHAFT
Meets annualy in different cities.

DUTCH SOCIETY OF ELECTROLOGY AND ROENTGENOLOGY
Holds two meetings a year in Amsterdam, one in the Spring, and one in the Fall.

SOCIETA ITALIANA RADIOLOGIA MEDICA
*Secretary*, Professor M. Ponzio, University of Turin, Turin.

SOCIETATEA ROMANA DE RADIOLOGIE SI ELECTROLOGIE
*Secretary*, Dr. Nicolae Busila, 44 Elizabeta Blvd., Bucarest.
Meets second Monday in every month with the exception of July and August.

ALL-RUSSIAN ROENTGEN RAY ASSOCIATION, LENINGRAD, USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
*Secretaries*, Drs. S. A. Reinberg and S. G. Simonson.
Meets annually.

LENINGRAD ROENTGEN RAY SOCIETY
*Secretaries*, Drs. S. G. Simonson and G. A. Gusterin.
Meets monthly on the first Monday at 8 o'clock in the State Institute of Roentgenology and Radiology, Leningrad.

MOSCOW ROENTGEN RAY SOCIETY
*Secretaries*, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky.
Meets monthly on the first Monday at 8 o'clock, the place of meeting being selected by the Society.

POLISH SOCIETY OF RADIOLOGY
*Secretary*, Dr. A. Elektorowicz, 19 Hoza St., Warsaw.
Meets annually.

WARSAW SECTION, POLISH SOCIETY OF RADIOLOGY
*Secretary*, Dr. B. Krynski, 11 Zielna St.
Meets once a month except in the summertime.

SCANDINAVIAN ROENTGEN SOCIETIES
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association. Each of the following societies, with exception of the Denmark Society, meets every second month except in the summertime:

SOCIETY OF MEDICAL RADIOLOGY OF SWEDEN
Meets in Stockholm.

SOCIETY OF MEDICAL RADIOLOGY IN NORWAY
Meets in Oslo.

SOCIETY OF MEDICAL RADIOLOGY IN DENMARK
*Secretary*, Dr. O. Wissing, Copenhagen.
Meets on the second Wednesday of each month from October to July in Copenhagen, at 8 o'clock in the State Institute of Roentgenology.

SOCIETY OF MEDICAL RADIOLOGY IN FINLAND
Meets in Helsingfors.

VIENNA SOCIETY OF ROENTGENOLOGY
*Secretary*, Professor Holzknecht, Vienna, IX, General Hospital.
Meets on the first Tuesday of each month from October to July.

## ROENTGENOLOGICAL CONFERENCE

The attention of roentgenologists is again called to the Roentgenological Conference to be held in Baltimore, Maryland, on February 6 and 7, 1931. The first announcement of this meeting appeared in the November issue of the Journal. The headquarters of the meeting will be at the Lord Baltimore Hotel. The opening session will be held at the Johns Hopkins Hospital on Friday morning at nine o'clock and the afternoon session at the University of Maryland Hospital. On Saturday morning the scientific session will be held at the Mercy Hospital, and on Saturday afternoon the Staff of the Howard A. Kelly Hospital will conduct a clinic on Radiation Therapy.

Dr. Charles A. Waters, 1100 North Charles St., Baltimore, who is chairman of the Committee of Arrangements, may be consulted for additional information with regard to the Conference.

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## BROOKLYN ROENTGEN RAY SOCIETY

The radiologists of Brooklyn have recently formed an organization to be known as the Brooklyn Roentgen Ray Society. Several preliminary meetings were held and the Society finally came into existence on December 2, 1930, at which time a constitution and by-laws were adopted. The officers of the Society are as follows: President: Charles Eastmond; Vice-President: William H. Bayles; Secretary-Treasurer: John J. Masterson. The Society meets monthly on the first Tuesday from October to April. The address of the secretary is 401 Seventy-sixth Street, Brooklyn, New York.

# DEPARTMENT OF TECHNIQUE

*Department Editor:* DAVID R. BOWEN, M.D., Pennsylvania Hospital, Philadelphia, Pa.

## IMMOBILIZING APPARATUS FOR TAKING CHEST ROENTGENOGRAMS IN YOUNG CHILDREN

*By* JEROME L. KOHN, M.D., *and* HENRY KOIRANSKY, M.D.
*From the Willard Parker Hospital for Contagious Diseases*
NEW YORK CITY

BECAUSE of their tendency to move, it is often difficult to get satisfactory roentgenograms of the chest in young children. This is especially true if one desires to get the exposure in a sitting position. Wimberger[4] has devised an apparatus for examining an infant in an erect position, the child being suspended from the axillae. This apparatus was later modified by Viethen.[2] Weymuller, Bell and Krahulik[3] have made a small frame with which they can hold small infants in a horizontal position. Pancoast and Pendergrass[1] have described a chair for taking roentgenograms of the upper respiratory tract in young children. In the chair used by them, it is necessary for some one to hold the infant or child. This is usually done by a nurse, a different nurse being used for each child, so as not to over-expose any individual to the roentgen rays. We wished to devise an apparatus for taking roentgenograms in a sitting position which would obviate this necessity of holding the patient.

A hardwood platform (Figs. 1, 2 and 3), 27×18 in. (68.6×45.7 cm.) and ¼ in. (0.6 cm.) in thickness is mounted on four legs 11 in. (27.8 cm.) in length, with a pair of uprights 30 in. (76 cm.) high. The platform extends 6½ in. (16.5 cm.) beyond the uprights. Each leg is mounted on a small pipe flange 3 in. (17.5 cm.) in diameter, by means of which it can be fastened to a permanent base or fixture if one so desires. The legs and uprights of the frame are made of ½ in. (1.25 cm.) pipe. Between these uprights there is an adjustable cassette holding device. This device is equipped to hold 10×12 in. (25.5×30.5 cm.) plates or any smaller size plates desired. This cassette holding device can be moved up and down and locked by means of screw clamps in any position, thus making it flexible as to the height of the child.

The cassette holder is made of hard wood, ¼ in. (0.6 cm.) in thickness and along its lower border it has a grooved projection of wood ¾ in. (2 cm.) in width to support the cassette in the cassette holder. Two

FIG. 1.

Fig. 2.

holes have been cut in the holder in order to allow the child's arms to protrude (Fig. 1), thus throwing the shadows of the scapulae out of the lung fields. The cassette is held in place by two small sliding wooden blocks. These blocks are grooved to fit over the cassette holder. These blocks are covered with thin bakelite, and on one side the bakelite extends ½ in. (1.25 cm.) beyond the block to hold the cassette. This block is 1⅜ in. (3.6 cm.) in thickness and 2 in. (5 cm.) long.

This apparatus is equipped with a Keleket immobilizing device (Fig. 2). The restraining or compression band, made of muslin, is put around the child, holding it at a slight pressure until the exposure is complete. All the fittings are standard and can be readily obtained. The chair can be made any size desired. It is not heavy and can be placed on the roentgen table at any desired distance from the tube. If one wishes to fasten the chair to the floor or other permanent fixture, the supporting legs can be made any length desired. In such case the platform can also be made smaller, and an independent tube stand may be used.

This special immobilizing apparatus is being used at the Willard Parker Hospital and has proved very satisfactory. In taking exposures of the chest, in the posteroanterior position, the child is held in place first by the restraining band and secondly by the lower end of the cassette holding device which rests on the thigh of the child. In older children, the legs hang over the edge of the platform. In younger children, the entire leg is on the platform, the child being unable to bend its knee. The arms are put through the holes in the cassette holder in order to throw the shadow of both scapulae out of the lung field.

In taking an exposure in the lateral position (Fig. 2), the child's legs are allowed to hang over the side of the platform. The chest is held against the plate by the com-

Fig. 3.

pression band and the arms held over the head. It is a little more difficult to keep the child quiet in this latter position, but if a quick exposure is made, a very satisfactory roentgenogram is obtained. If this is not possible, two partially inflated football bladders may be placed in front and in back of the child between the band and the cassette holder. The child can then be rotated to the desired position and is thus immobilized.

When this apparatus is used in a hospital for contagious diseases such as the Willard Parker, the roentgen plate is put in a linen slip, the platform is covered with a piece of muslin, and the restraining band is also changed. In this manner, it is possible to carry out a strict technique, reducing the chances of cross infection to a minimum and at the same time completely immobilizing the child for the roentgenographic exposure.

## REFERENCES

1. PANCOAST, H. K., and PENDERGRASS, E. P. Roentgenologic diagnosis of diseases of the upper respiratory tract in children. AM. J. ROENTGENOL. & RAD. THERAPY, 1930, *23*, 241–264.
2. VIETHEN, A. Verbessertes Säulingsstützbänkchen für Durchleuchtungen (nach Wimberger). *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1926, *34*, 554.
3. WEYMULLER, C. A., BELL, A. L. L., and KRAHULIK, L. Roentgenographic changes in the thorax of normal new-born babies. *Am. J. Dis. Child.*, 1928, *35*, 837–855.
4. WIMBERGER, H. Technische Erfahrungen aus der Kinder-röntgenologie. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1922, *29*, 96–99.

# BOOK REVIEWS

*Books Received Are Acknowledged under Heading: Books Received. This must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.*

Diseases of the Skin. A Text-Book for Practitioners and Students. By George Clinton Andrews, A.B., M.D., Associate Professor of Dermatology, College of Physicians and Surgeons, Columbia University; Consulting Dermatologist and Syphilologist to Tarrytown Hospital; to St. John's Hospital, Yonkers; to Grassland's Hospital, and to the Broad Street Hospital, New York City. Cloth. Price, $12.00. Pp. 1091, with 988 illustrations. Philadelphia and London: W. B. Saunders Co., 1930.

Dr. Andrews' new publication on "Diseases of the Skin" is well worth a careful examination. He has taken unusual care to include the latest facts in diagnosis and treatment, and the style, general make-up and contents of the book are excellent. No claim is made for an ideal classification of skin diseases; indeed, the belief in the impossibility of such an attainment is expressed. The arrangement used is simple, practical and does not strain the imagination by an effort to group diseases between which the average student can see no plausible relationship. Excellent bibliographies follow each chapter.

Following the usual and logical custom several initial chapters are devoted to anatomy, physiology, pathology, and general diagnosis, which subjects are treated briefly and yet with sufficient detail for a practical work. The principles of treatment are dealt with concisely and clearly, and in this part of the book is included a large group of useful prescriptions for convenient reference, in addition to the special formulas given in the discussion of the individual diseases.

The radiologist will find the chapters on radiation therapy of particular interest. Some sixty pages are devoted to roentgen therapy, including physical considerations, and dosage of filtered and unfiltered roentgen rays, with lists of skin lesions in which roentgen irradiation is indicated. Although the usual formulas are given, the reader is warned that they may vary as much as 150 or 200 per cent when transferred from one machine to another. Throughout the discussion are interspersed important observations which make a careful reading well worth while.

An entire chapter is allotted to radium therapy, the author going into some detail as to the technique. He recognizes the fact that the same biological effect can be produced by both roentgen rays and radium, the preference for either in a given case being a matter of convenience of application, time consumed in treatment, and necessity of effective filtration to deliver sufficiently hard rays to a given depth.

Dr. Andrews is doubtful whether any special designation is warranted for the so-called "Grenz rays," since they are merely roentgen rays of long wave length, but he chooses to follow the suggestion of Kaye and call them w-rays. The wisdom of this terminology may well be qestioned, especially in view of a too general impression that they are different from roentgen rays and are harmless. However he takes pains to refute this notion.

Valuable chapters are those on ultraviolet light and surgical diathermy for the average radiologist is too apt to be unfamiliar with these subjects. Though it is stated that ultraviolet light has been over-rated in therapy and is far inferior to roentgen rays in usefulness nevertheless many indications and instructions are given for its use. The advantages of electrical desiccation, coagulation and carbonization in the removal of certain diseased tissues are explained and the technique well demonstrated.

About twenty-five pages of the chapter on dermatoses due to physical causes are devoted to roentgen and radium dermatitis. The thorough consideration of this condition is of great value in practical work and might give particular aid in a troublesome medicolegal case which may sooner or later involve any dermatologist or radiotherapist.

We commend the judgment of the author in omitting the eruptive fevers which are always fully treated in texts on pediatrics and internal medicine. By this omission he has been able to include in a convenient volume subjects of more practical value to the radiologist and dermatologist.

E. W. Hall

TUBERCULOSIS AMONG CHILDREN. By J. Arthur Myers, Ph.D., M.D., F.A.C.P., Chief of Medical Staff, Lymanhurst School for Tuberculous Children, Associate Professor of Preventive Medicine, University of Minnesota. Cloth. Price, $3.50. Pp. 208, with 43 illustrations. Springfield, Illinois: Charles C. Thomas, 1930.

This book is valuable because it presents a large amount of information in a simple and understandable way, is fit to serve as a sound and practical guide for students and physicians, and fairly represents the present knowledge of the behavior of tuberculosis in children, particularly as that knowledge has been enhanced by roentgen studies. In fact, the work reflects the modern tendency to regard clinical manifestations and physical signs—or the lack of them—as very untrustworthy, and to place most reliance on the roentgenogram for diagnosis and in many cases as the main guide in treatment. In the past ten or fifteen years, roentgenological procedures have without question accomplished more in elucidating the peculiarly difficult problems of tuberculosis in children than has any other one method. Yet even this advance leaves us in the dark on certain points. In a goodly percentage of children with positive tuberculin skin tests, the roentgen ray does not reveal the lesion. This may be an extrathoracic focus or a fresh lesion in the tracheobronchial lymph nodes which casts no distinctive roentgen shadow. Here then the roentgen ray falls just as far short as the physical examination, and as yet none have been able to tell us which of these children harbor disease that is a menace and which have small morbid lymph node changes that will in all likelihood remain innocuous. True enough, the roentgen ray puts us a long step ahead, but in deciding on the management of a given case one should assume that negative roentgen findings, not to mention negative physical findings, do not weigh as heavily as positive findings, a point not clearly emphasized by Myers. Negative roentgen evidence in children is much less dependable than similar evidence in adults, due to the inherent differences of the pathology as well described by Myers. Long experience with tuberculous children in the Lymanhurst School (Minneapolis) enables the author to speak authoritatively on the potential meaning of various early lesions, but one could wish for a more complete and critical correlation of the accumulated data. Very little that is new is contributed to our knowledge of the meaning of the tuberculin reaction in relation to the clinical state, probably because we have reached an impasse in trying to solve this puzzle. Treatment is considered rather sketchily: we need more information to enable us to decide when a child needs treatment and when treatment is no longer necessary. The book makes no pretense at profundity and is obviously not intended to be more than a summary of available facts in the light of the author's experience. What it lacks in critical analysis is made up in clearness and usefulness. Its shortcomings, in most respects, reflect the deficiencies of our present knowledge. Myers must be credited with shaking off many obsolete and false ideas of the subject that heretofore have been perpetuated unwisely by other writers, and with attempting with a commendable degree of success to found his conceptions on established principles of pathogenesis.

In form and typography the book is pleasing; misspellings are a little too frequent.

J. BURNS AMBERSON, JR.

SELECTED READINGS IN THE HISTORY OF PHYSIOLOGY. Edited by John Farquhar Fulton, M.D., Formerly Fellow of Magdalen College, Oxford; Sterling Professor of Physiology, Yale University. Cloth. Price, $5.00. Pp. 317, with 60 illustrations. Springfield, Illinois: Charles C. Thomas, 1930.

Having just finished reading this book and being still under its spell, I am almost afraid to break the silence. But my reader, not having just read the book, should not be averse to hearing a word spoken in its praise.

The editor, the Sterling Professor of Physiology in the Yale University School of Medicine, has panned out for us about eighty-five nuggets of physiologic writing, each one a significant expression of its period or an important contribution to the science. Thus we are de luxe students of history, riding along a famous trail, via pullman, which pioneers crawled along for centuries.

We start with the ancients' speculations, Aristotle's and Galen's, or with the puzzling experiments of Jean Rey and Robert Boyle, and are carried along to the discovery of Brownian movement, or the astounding declarations of Harvey, watching the science grow as Malphighi, van Leeuwenhoek, Spallanzani, and De Graf fit their pieces into this magic struc-

ture, growing now apace but solid as coral. And as the world is opened to communication, discoveries come from Beaumont in the North woods, as well as from Claude Bernard in Paris. Even to mention all the selections would be tedious; suffice it to say physiologic development is brought up to our own day.

The great virtue of this collection is that, while presenting the material in systematic arrangement, it preserves the charm of originality and reality; the dramatic triumphs of science are reenacted for us, even with the quaint speech and spelling of other days.

Every medical booklover and every student of medical history will want this book on his shelf. It is well printed and illustrated.

CHARLES E. DUTCHESS

ÉTUDE CLINIQUE ET RADIOLOGIQUE DES OSTÉITES CONDENSANTES BÉNIGNES (OSTÉITES PICNOTIQUES). By Docteur Paul-Marie Bernard, ancien externe des Hôpitaux de Paris. (Travail du Service du Professeur Sicard.) Paper. Pp. 119, with 35 illustrations. Grasse, Impressions "Frago," 1929.

This volume consists of a study of condensing types of osteitis of bone of unknown etiology, first described by Sicard, which can be considered, the author believes, as a separate pathological disease entity.

The first chapter gives a short description of the roentgenographic appearance of bone, a rather detailed biological-histological study of bony tissue and a consideration of the phenomena of rarefaction and of condensation of bone.

The second chapter is given over to the clinical course of the condensing types of osteitis as described by Sicard. The symptoms are localized to the region of the lumbar vertebrae and the pelvis, either unilateral or bilateral. They may continue for a long period of time or may disappear completely, although in the latter case the condensation as seen in the roentgenograms persists. In some cases neuritis or an atrophy of the musculature may be noticed, also disturbances of gait, traceable to the atrophy, may be present. Pain is more or less influenced by symptomatic treatment. The skin in the affected region is sometimes warm and hyperesthetic and can simulate in appearance changes caused by an acute or chronic inflammation of bone.

Roentgenologically the bony structure is profoundly modified, and as a rule changes are usually symmetrical. Condensation of bone with thickening and exaggeration of the picture of the bony structure, and hypercalcification are present, giving a much denser than normal opacity in the roentgenogram. The bony borders and outlines are not changed, likewise the contours of the joints are not affected. The areas of condensation may be diffuse or isolated, in the latter case sometimes being found lying far distant from other foci in apparently otherwise healthy bone. Articular capsules and ligaments of joints may be calcified as is sometimes found in other diseases. In all the cases studied there was no sign of periostitis nor was there any evidence of osteophyte formation. He reports six cases in detail with illustrative roentgenograms.

In the third chapter, the author discusses the differential diagnosis from chronic suppurative osteomyelitis showing condensation of bone, tuberculosis, syphilitic gummas, metastatic carcinoma of the prostate and other forms of carcinoma, central or peripheral sarcoma of bone, and other systemic diseases, such as Albers-Schönberg's disease (marble bones), osteopoecilia, the rare case reported by Voorhoeve as a form of chondrodysplasia, the eburnating osteitis of Putti, unilateral chondrodysplasia or Ollier's disease, and several other cases reported by various authors simulating this condition.

The fourth chapter continues this discussion, taking up the characteristic lesions and appearances of Paget's disease, osteitis fibrosa cystica, leontiasis ossea, the melorheostose of Leri or "flow-hyperostosis."

A peculiar case of Sicard's type is described in the fifth chapter which showed numerous small scattered areas of condensation, which Sicard termed the type "picnotique."

In the sixth and concluding chapter the author recommends a roentgenographic technique, lists the possible causes of error in interpretation and warns especially against faulty technique in roentgen examination. A fairly voluminous bibliography is appended.

This work is of interest and is valuable in that it calls attention to a type of bone sclerosis or osteitis which has been little discussed in American roentgen literature. It is an excellent contribution to the slowly growing data on the rare and infrequent types of osteitis showing condensation of bone.

R. S. BROMER

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# ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

## ROENTGEN DIAGNOSIS

### NECK AND CHEST

Heimbeck, Johannes. Tuberculosis incipiens. *Klin. Wchnschr.*, June 25, 1929, *8*, 1206–1208.

During the past five years the author examined a group of 581 pupil nurses on duty at the Ullevaal Hospital (a tuberculosis institution). When beginning their training 282 of the nurses showed a positive Pirquet reaction, while in 299 the reaction was negative. Of the first group only 5 nurses have developed tuberculosis of some sort during the three year training, while of the second group 66 cases became tuberculous. Since 1927 in 57 nurses roentgenograms of the chest were taken previous to the admission with entirely negative results. Nine of these later contracted tuberculosis and the roentgenograms revealed evidence of a tuberculous infiltration which was localized chiefly to the subclavicular region.

The conclusion is reached that latent tuberculosis of early childhood of the first infection period (as evidenced in the Pirquet positive cases) is only rarely responsible for the development of tuberculosis in adolescence. In most instances there is primary infection (as evidenced in the Pirquet negative cases) in adolescence which the author calls the second infection period. The process is localized chiefly to the lungs, appearing in the form of primary infiltrations of the subclavicular region. Occasionally they are associated with erythema nodosum and pleuritis.—*T. Leucutia.*

Zawadowski, Witold. Le lobule de la veine azygos (lobule de Wrisberg); sa visibilité sur les radiographies pulmonaires. (Vena azygos lobe (Wrisberg); its visibility on the pulmonary roentgenogram.) *J. de radiol. et d'électrol.*, May, 1930, *14*, 273–282.

This article constitutes a summary of the various views and classifications of azygos lobe. The author himself observed 17 cases which are classified according to Stibbe into: type *a* (the fissure beginning laterally from the right apex); type *b* (the fissure beginning at the top of the apex), and type *c* (the fissure beginning medially from the apex). According to Cairney the ratio of the three types is as follows: *a*, 40.97 per cent; *b*, 32 per cent; *c*, 27.1 per cent.

The incidence of the azygos lobe in the author's cases was 0.33 per cent. In none of the cases was there evidence of a pathological condition. In one instance, however, the azygos lobe was associated with other developmental anomalies of the right side of the neck (spina bifida occulta of the first dorsal vertebra, right cervical rib and bifurcation of the right first normal rib).—*T. Leucutia.*

Conrozier, and Magnin. Apropos de la silicose pulmonaire. (Concerning pulmonary silicosis.) *Bull. et mém. Soc. de radiol. méd. de France*, April, 1930, *18*, 181–183.

By means of roentgenograms the authors examined the chests in 22 miners (stone tunnel workers) and found that all had intrathoracic changes, regardless of whether clinical symptoms were present or not. The men were between forty and forty-five and had been working for a period of four to fifteen years. It is emphasized that stone cutting (in southern France) is a very dangerous occupation, some of the above miners representing the last survivals of a group of workers now becoming extinct.—*T. Leucutia.*

Sergent, Emile. Le lipiodo-diagnostic et les fausses images cavitaires. (Diagnosis by means of lipiodol in pseudo-cavities.) *Presse méd.*, June 18, 1930, *38*, 825–837.

The injection of lipiodol is of great value in demonstrating pseudo-cavities within the chest. These, in the majority of instances, are the result of dilated bronchi (sacciform bronchiectases) which appear more opaque on the roentgenograms, and by overlapping might lead to formations similar to walls of true cavities. The injected lipiodol will enter the dilated bronchi and thus help to establish a correct diagnosis. It must be mentioned, however, that in some instances stereoscopic films are necessary in order to differentiate overlapping bronchial branches.

Several roentgenograms are reproduced in order to prove the value of the method.—*T. Leucutia.*

CORYLLOS, POL. N. Treatment of bronchiectasis—multiple stage lobectomy. *Arch. Surg.*, May, 1930, *20*, 767–801.

Bronchiectasis may be divided clinically into the following varieties: (1) Bronchitic form (Ochsner) with slight dilatation shown only by iodized oil injections. No parenchymal involvement. No classical symptoms. (2) Early uncomplicated bronchiectasis showing definite bronchial lesions but no pneumonitis. Usually unilateral. Moderate symptoms. (3) Bronchiectasis complicated with pneumonitis and even small multiple abscesses. Classical symptoms. (4) Bronchiectatic abscesses—an increase of No. 3.

Bronchiectasis is a progressive disease. Early diagnosis is essential for control.

The bronchitic form often responds to treatment of the upper respiratory tract and sinuses, hygiene, hot dry climate and bronchoscopic drainage.

The early uncomplicated form should be treated as above, plus the consideration of compression therapy. Pneumothorax, phrenicectomy and thoracoplasty associated with bronchoscopic drainage and antispirochetal treatment when necessary are often helpful.

The third form has but one cure—surgical exeresis of the diseased portion of the lung by lobectomy, cautery pneumectomy or exteriorization and ligation.

Death from lobectomy can be ascribed to: (1) Shock which is usually mechanical from compression of the opposite lung upon sudden opening of the thorax in one-stage operations. (2) Embolism due frequently to cough during operation. (3) Hemorrhage, primary or secondary, due usually to carelessness in ligation and dissection during operations requiring speed. (4) Increased intrathoracic pressure due to tension pneumothorax or fluid following operation.

These dangers can best be avoided by multiple stage lobectomy which is performed in the following steps: (1) Preliminary pneumothorax for several weeks. Adhesions are rare except in postempyema cases or where there have been frequent thoracenteses. The opposite lung gradually accepts the entire burden of respiration and the lesser circulation becomes accommodated. The mediastinum becomes firmer and the patient's general condition improves because of decreased lymphatic and blood stream absorption of toxins. The pleura becomes less absorptive. (2) Phrenicectomy reinforces the phenomena produced by pneumothorax and also decreases the size of the thoracic cavity and further immobilizes the operative field. (3) Thoracoplasty over the affected area brings the operative field near the surface, simplifies the problem of exposure and greatly decreases the thoracic cavity to be filled by the reëxpanding remaining lung. (4) Lobectomy then is performed without the stress of the necessity of speed. The thorax is opened as safely and easily as the abdomen. (5) The procedure is carried on under high spinal anesthesia. Thus coughing and respiratory stress are eliminated.

One case of multiple stage lobectomy and one case of cautery pneumectomy preceded by phrenicectomy and thoracoplasty have been cured for two years.—*G. R. Miller.*

REMY-ROUX. Deux cas de kyste hydatique et un cas de faux kyste du poumon. (Two cases of hydatid cyst and one case of false cyst of the lung.) *Bull. et mém. Soc. de radiol. méd. de France*, April, 1930, *18*, 184–189.

Two cases of hydatid cyst of the lungs are briefly described and the roentgenograms presented. In connection with this, the differential diagnosis from pseudo cysts is discussed and one instance cited for the purpose of illustration. This consisted in a large abscess of the left lower lobe associated with tuberculosis of the entire left lung; at the re-examination several months later the abscess had entirely disappeared (spontaneous evacuation).—*T. Leucutia.*

LAMARQUE, and CHAPTAL. A propos d'un cas de kyste dermoïde intra-thoracique. (A case of intrathoracic dermoid cyst.) *Bull. et mém. Soc. de radiol. méd. de France*, April, 1930, *18*, 189–191.

A case of intrathoracic dermoid cyst, occurring in a man thirty-six years of age, is briefly described. The diagnosis was made from the fact that teeth could be demonstrated in the roentgenograms and that the patient had expectorated hair in several instances. The cyst, which originated in the posterior mediastinum, had broken through into the bronchus.—*T. Leucutia.*

BONNER, LILA M. Primary lung tumor. *J. Am. M. Ass.*, Apr. 5, 1930, *94*, 1044–1049.

Primary lung cancer, best diagnosed in its early stages by the roentgenogram, is becoming more frequent, causing from 5 to 10 per cent of deaths from cancer. It occurs more frequently in men and is commonest in the sixth decade. Abscess is often a complication and tuberculosis may be present. Cardinal symptoms are pain, dyspnea, cough, sputum and fever.

The following is a clinical classification: (1) slight symptoms from a small nodule; (2) severe symptoms from extensive involvement; (3) symptoms due to invasion of, or pressure on, the mediastinum, and (4) symptoms from extensive metastasis from an asymptomatic tumor.

Early surgery offers the only hope of cure. Roentgen therapy is occasionally palliative.—*G. R. Miller.*

Farrell, John T. Roentgen diagnosis of cancer of the esophagus. *Radiology*, March, 1930, *14*, 282–292.

The author feels that the present status of the diagnosis and treatment of cancer of the esophagus is unsatisfactory because of the impossibility of cure at the late stage at which these patients come under observation, and he stresses the point that even the slightest difficulty in swallowing should be investigated thoroughly before it is dismissed as inconsequential. Roentgenology offers the most universally practical method for the diagnosis of diseases of the esophagus, and in all conditions in which a positive diagnosis as to the presence or absence of organic disease of the esophagus cannot be made by roentgen study, esophagoscopy should be employed.

In Farrell's series of 77 cases of cancer of the esophagus, the disease occurred 15 times in the upper third, 30 times in the middle, and 32 times in the lower. A filling defect was observed in all patients; in but one instance was it smooth; in the other 76 it was irregular. Narrowing at the site of the growth was a constant finding. Slight dilatation of the proximal portion was present in 73 instances; in 4 it was absent. No relation existed between the site of the growth and the absence of dilatation. Farrell states that increased peristalsis is not a prominent feature of cancer of the esophagus. Metastases and lower lobe pulmonary infections occur as occasional complications. Erosion of the trachea or a bronchus, with the creation of a fistulous tract, is rare. The following organic lesions must be differentiated from cancer of the esophagus: cicatricial stenosis from external pressure, esophageal varix, diverticulum, benign esophagitis, foreign body, and extension of gastric malignancy. Phrenospasm, or so-called cardiospasm, central nervous system lesions such as bulbar palsy, localized lesions of the nerves controlling the muscles of swallowing, globus hystericus, and hysteria are the functional conditions which must be differentiated.—*J. D. Camp.*

Keller, William L. Massive diaphragmatic hernia without diagnostic symptoms. *Am. J. Surg.*, March, 1930, *8*, 598–604.

Diaphragmatic hernia is being recognized with increasing frequency because of better methods of investigation. The author stresses the fact that even large diaphragmatic hernias may be overlooked unless the patient is given an opaque meal and the examination is made in the erect and prone positions.

Richard's classification of hernias is reviewed: I. True hernias: (*a*) congenital; (*b*) acquired; (*c*) traumatic; (*d*) non-traumatic. II. False hernias: (*a*) congenital; (*b*) acquired. III. Eventration of the diaphragm.

Some of the literature is reviewed and the author reports 2 cases detailing the steps of the operative procedure.—*G. R. Miller.*

ABDOMEN

Boman, P. G. Compression technic in gastroduodenal roentgen diagnosis. *J. Am. M. Ass.*, Feb. 15, 1930, *94*, 464–468.

Direct roentgenographic evidence of gastroduodenal pathology can be elicited by the compression technique of Åkerlund and Berg. A combined fluoroscopic and roentgenographic unit is used which can change rapidly from one type of exposure to the other by pressure on a foot switch. A serial exposure device is attached to the fluoroscopic screen which is also arranged so that it can press against the patient's abdomen. Only 1 or 2 ounces of barium mixture is given. The mucosa is directly visualized under compression by fluoroscopy and the smaller lesions usually obliterated by a larger barium meal will be demonstrated. Roentgenographic records can be made rapidly as they are observed with the apparatus described.—*G. R. Miller.*

TARTAGLI, DINO. Alcuni casi di anomalie congenite dell'intestino. (Some cases of congenital anomaly of the intestine.) *Radiol. med.*, March, 1930, *17*, 251–261.

Nine cases are described which showed progressive degrees of anomaly of the intestine.

In cases 1, 2, 3 and 4 there was only a progressively increasing irregularity in the course of the third portion of the duodenum while the other parts of the duodenum and the duodenojejunal junction were normal. The author calls this a partial free duodenum. In these cases there were no other visceral anomalies. Cases 5 and 6 were ones of classical free duodenum, but even these showed progressive increase in the symptomatology, for in case 5 only the first loop of the jejunum was ectopic while in case 6 all of it was. In cases 7 and 8 the free duodenum was associated with common mesentery, which was more marked in case 7 than in case 8. In case 9 these anomalies were accompanied by inversion of the viscera. These anomalies are due to varying degrees of arrest of development and rotation of the intestine in the course of embryological development.

The subjective symptomatology was not always in proportion to the degree of anatomical abnormality. In cases 2, 3, 4 and 6 there had been only vague symptoms for a relatively brief period and these were adult or even old individuals. There had evidently been perfect functional adaptation to the anomaly until some other factor intervened to cause disturbance. In cases 5 and 7 the symptoms, which were quite recent, did not at all suggest the roentgen findings. Apparently the symptoms were caused by changes in the chemistry of the gastric juice. In cases 8 and 9 there were old symptoms in proportion to the anatomical disturbances. The patient in case 8 showed a vagus syndrome manifested by psychic depression and extreme sensitiveness. There was nothing to explain the pain in case 1, in which the patient was admitted with a diagnosis of ulcer but no ulcer was found; the enlarged bulb of the duodenum did not seem to be sufficient to explain the symptoms any more than the partial mobility of the duodenum.—*Audrey G. Morgan.*

ZUKSCHWERDT, L. Duodenal Divertikel und Magengeschwür. (Duodenal diverticula and gastric ulcer.) *Klin. Wchnschr.*, June 18, 1929, *8*, 1171–1174.

Duodenal diverticula may be found as accidental occurrences without symptoms or as a definite disease entity or finally in association with gastric ulcers. The author describes in detail a case in which there was evidence of two duodenal diverticula associated with a gastric and a duodenal ulcer. It is most probable that the diverticula because of stagnation have led to the formation of ulcers.—*T. Leucutia.*

ASCHNER, PAUL W., and KARELITZ, SAMUEL. Peptic ulcer of Meckel's diverticulum and ileum. *Ann. Surg.*, April, 1930, *91*, 573–582.

Heterotopic gastric mucosa has been shown to occur at the umbilicus and in Meckel's diverticulum, the result of anomalous developmental structures arising from the omphalomesenteric duct. Chronic ulcers causing pain, very typically frank hemorrhage by bowel, and perforation occurred in Meckel's diverticulum and the ileum in 33 cases. These histologically were identical with peptic ulcer. In 21 of these cases gastric mucosa was demonstrated in the diverticulum, and the ulcers occurred in the intestinal type of mucosa adjoining the gastric. The suggestion is strong that hydrochloric acid is a factor in ulcer formation. Cure by resection of the gastric mucosa in these cases encourages the idea that elimination of free hydrochloric acid is helpful in the treatment of peptic ulcer. —*G. R. Miller.*

HĂNGANUT, MARIUS. Consideraţiuni clinice si radiologice asupra torsiunei intestinale in viaţa embrionară, oprire in torsiune. (Clinical and roentgen considerations of intestinal torsion in embryonal life and arrest of torsion.) *Cluj. med.*, April, 1930, *11*, 172–176.

The author describes in detail 3 cases of mesenterium commune which were observed in a total of 2000 gastrointestinal examinations. The following roentgen signs are considered as characteristic. There is a mobile duodenum and the duodenojejunal angle is situated to the right of the spine or directly on the vertebral column. The entire small intestine is massed to the right of the midline, while the large intestine lies to the left. The ascending colon is very short, the hepatic flexure absent and the transverse colon runs obliquely upwards and to the left. The descending colon and the sigmoid are normal. Unless there is evidence of perivisceritis or torsions there is an increased movability, especially of the small intestines.

The author does not agree with Altschul that the duodenum forms a typical picture; on the contrary, the appearance of the duodenum may be very manifold, depending on the degree of torsion and the flexure anomalies of the various segments of the duodenum (mobile duodenum).

The mesenterium commune is a developmental anomaly resulting from incomplete torsion of the gastrointestinal tract.—*T. Leucutia.*

Morrison, L. B. The rôle of x-ray in the diagnosis of carcinoma of the colon. *New England J. M.*, Sept. 4, 1930, *203*, 441–455.

This is a well-rounded lecture by a roentgenologist to a group of general surgeons in which the author cites the advantages of the barium enema over the barium meal in the study of the colon. He calls attention to the fact that cancer occurs in the colon in either the ulcerating, fungating type of growth or the constricting annular scirrhous type (25 per cent of cases). A series of 102 cases is analyzed.—*P. A. Bishop.*

Poirot. Amélioration des résultats de la cholécystographie par la diathermie. (Improvement of the results of cholecystography with diathermy.) *Bull. et mém. Soc. de radiol. méd. de France*, May, 1930, *18*, 231–232.

The author advises the use of diathermy and biliary salts for intensifying the gall-bladder shadow in all cases in which the dye examination fails to give satisfactory results. The method of procedure is as follows: If the dye is administered intravenously, one hour following the injection the liver is treated for half an hour with diathermy (the applications being repeated several times, if necessary, for a period of three to five hours). In some instances the combination of diathermy with intravenous injection of biliary salts is necessary. The biliary salts acting as cholegogues, intensify the gall-bladder shadow, and at the same time accelerate the evacuation, producing complete emptying within half an hour.

If the dye is administered by mouth purgatives are given the day previous to the examination. The same night hypophysin and atropine are injected and half an hour later 3 to 4 gm. of tetraiodophenolphthalein is administered (per os). The next day if the first roentgenogram shows no filling of the gall-bladder, a seance of diathermy is applied and this is followed by the administration of 4 tablets of biliary salts.

By using this method the author succeeded in demonstrating a gall-bladder shadow in many instances which otherwise would have remained negative.—*T. Leucutia.*

SKELETAL SYSTEM

Diamant-Berger, L., Pétrignani, R., and Lifchitz. Contribution à l'étude des malformations du rachis cervical. (Contribution to the study of malformations of the cervical spine.) *Presse méd.*, June 18, 1930, *38*, 833–835.

The author describes a rather interesting malformation of the cervical spine which occurred in a boy aged five. There was absence of the arch of the fourth and of the body of the seventh vertebrae.

Developmental anomalies of the cervical spine are classified as follows: (*a*) numerical variations of the components of the cervical column; (*b*) morphologic variations of the isolated vertebral elements; (*c*) numerical and morphologic variations combined; (*d*) variations of differentiation (classification of Putti). The above case cannot be placed in any of these four groups. It is the authors' contention that it represents a developmental anomaly consisting in substitution of segments (the two semi-segments forming one complete vertebra).—*T. Leucutia.*

Roederer, C. Nouvelle observation d'une calcification du nucleus pulposus. (New observation of the calcification of the nucleus pulposus.) *Bull. et mém. Soc. de radiol. méd. de France*, May, 1930, *18*, 224–226.

The author describes a case of calcification of the nucleus pulposus occurring in a man forty years of age who, as a result of a trauma during the war, developed a gradual kyphosis. The roentgenograms of the spine revealed a calcification of the nucleus pulposus (between the 9th and 10th dorsal vertebrae) which no doubt was responsible for the kyphosis. The lesion was associated with severe pain and marked contracture. The condition is described because of its rarity.—*T. Leucutia.*

Camplani, Mario. Contributo allo studio dello scheletro nella tabe e nella siringomielia. (Bone lesions in tabes and syringomyelia.) *Radiol. med.*, March, 1930, *17*, 294–324.

There are bone lesions in a certain number of cases of tabes dorsalis, a number estimated by Lotheisen and Hesse at 10–12 per cent and by Marie at 5 per cent. There are similar changes in some cases of syringomyelia. Illustrative cases are described and the roentgen picture and pathogenesis of these lesions discussed in detail. Examinations are then reported of the skeletons of 8 tabetics who did not have arthropathy. These cases seem to show that there is a prearthropathic condition, as there were lesions in certain parts of the skeleton that might explain the arthropathy and also the fractures that frequently occur in these cases. The roentgen appearance of the bone and joint lesions in these cases even suggests a certain relationship to arthritis deformans; but this is not constant and it is probable that the spirochete does sometimes cause or complicate these bone lesions and that they are not all of a single type but of at least two.—*Audrey G. Morgan.*

PIFFAULT, BARREAU and ROY. Arthropathie de la hanche chez un tabétique. (Arthropathy of the hip in a tabetic.) *Bull. et mém. Soc. de radiol. méd. de France*, May, 1930, *18*, 230–231.

The following roentgen signs are considered characteristic for tabetic arthropathies of the hip: Destruction of the femoral head with increased density of the cervico-capital portion, complete deformity of the articular surfaces, opacification of the capsule and presence of intra-articular foreign bodies.—*T. Leucutia.*

POTENZA, VITO. Un caso di rotula tripartita. (A case of tripartite patella.) *Radiol. med.*, March, 1930, *17*, 289–293.

A man of thirty fell from a ladder and caught his foot between two of the steps, falling on his back. He was admitted to the hospital for spinal symptoms from which however he recovered after two weeks' rest in bed. He then began to complain of pain in his left knee and collected damages for injury of the knee. After that he collected damages from another company in which he was insured for similar symptoms in the right knee. Roentgen examination of the left knee showed the patella divided into three fragments. There were no signs of callus and the outlines of the fragments were very distinct. The fragments were distinctly visible in the lateral as well as the anteroposterior direction. There were no changes in the joint heads. The picture suggested a congenital lesion rather than a fracture. Examination was then made on the right side and the findings were the same.

Divided patella is not infrequent but it is more frequently bipartite than tripartite. Both an anteroposterior and lateral exposure should always be made in examining for it. As divided patella has sometimes been seen in patients with classical osteochondrodystrophy, the author thinks it may be due to a juvenile osteochondrodystrophy. The case is interesting because of the fact that it may be important in industrial accidents.—*Audrey G. Morgan.*

CONTE, ETTORE. La condromatosi articolare. (Joint chondromatosis.) *Radiol. med.*, March, 1930, *17*, 237–251.

Reichel in 1900 first described this disease in which the chief process is hyperproduction of cartilage by the synovia; it differs both from chronic inflammation and from chondrosarcoma of the joints and he gave it the name of joint chondromatosis. The author describes 3 cases, one in the hip, one in the knee and one in the elbow joint and gives roentgenograms illustrating the changes. Clinically the beginning of the disease is gradual; the patient has some pain and a little interference with the movement of the joint but is able to work. The disease does not become very troublesome until free joint bodies form and the synovial membrane thickens. The joint bodies may still further interfere with movement and cause much pain. In extreme cases there may be complete or almost complete ankylosis in a position of flexion or extension, depending on which causes the patient the least pain. The beginning period of pain may be followed by a period of adaptation in which function is strikingly well preserved in proportion to the anatomical changes. The degree of pain depends partly on whether nerve trunks are compressed by the cartilage vegetations. There are no signs on inspection except perhaps slight atrophy of the muscles. In the author's second case there was sometimes a little swelling of the knee, but only on exertion or fatigue. But palpation, especially in advanced cases, shows bodies in the joints that are sometimes fixed and sometimes movable. When there are many small joint bodies there is sometimes crepita-

tion. Sometimes hydrarthrosis develops and interferes with clinical examination.

Absolute diagnosis can be made by roentgen examination when the joint bodies have become ossified or mineralized to a certain extent. Even in early cases there may be little groups of cartilage nodules in the synovial recesses; they look like transparent glass beads and never grow any larger. The best method of examination is stereographic or stereoscopic. Ordinary roentgen examination may sometimes be uncertain on account of the almost complete ossification of the capsule. In such cases stereoscopic examination shows the free bodies in the joint space.

The chief point in differentiating this disease from arthritis deformans, which it greatly resembles, is that the bones are intact. In arthritis deformans there are changes in the bones and osteophytes. In some cases of chondromatosis there are no joint bodies but only lesions of the synovia.

Molonguet says that it has not been proved that chondromatosis is a separate disease for sometimes there are bone lesions and osteophytes, and histologically the lesions in this disease are just like those in other diseases of the synovia. But the author holds that if there are bone lesions they are caused by an arthritis developing in a joint affected with chondromatosis. Another argument in favor of its being an independent disease is that removal of the free bodies is almost always followed by recovery in chondromatosis while in arthritis deformans no surgical operation can prevent the further progress of the disease.

The cause of chondromatosis of the joints is not known. The fact that the joint bodies may form again after removal and the bones remain intact is an argument in favor of its being neoplastic in nature. Brenckmann says that the joint bodies of chondromatosis are different from those of traumatic, tabetic, arthritic or other origin and histological examination seems to indicate that they are benign new-growths, from a metaplasia that has nothing to do with arthritis deformans. The author thinks that joint chrondromatosis is definitely an independent disease.—*Audrey G. Morgan.*

Eljasz, Anna. Late congenital syphilis. *Arch. Dermat. & Syph.*, Aug., 1930, *22*, 274–280.

A classification of the lesions of bones and joints in congenital syphilis is given as follows: (1) Bone changes: (*a*) osteochondritis; (*b*) periostitis; (*c*) osteomyelitis gummosa; (*d*) osteomyelitis fibrosa rareficans (Pick's osteoporosis hypertrophica); (*e*) overgrowth of long bones caused by degeneration of epiphyseal cartilages. (2) Arthropathies: (*a*) arthritis suppurative; (*b*) polyarthritis serosa. (3) Osteoarthritis.

A case is reported in which the bone lesions are uncommonly generalized.—*P. A. Bishop.*

GENERAL

Guarini, C. Sette anni di lavoro presso l'Istituto Fotoradioterapico di napoli. Considerazioni clinico-statistiche su 12,455 infermi avuti per cure ed indagini diagnostiche. (Seven years of work at the Photoroentgen-therapeutic Institute of Naples. Clinical and statistical facts in regard to 12,455 patients given diagnostic and therapeutic irradiations.) *Arch. di radiol.*, Nov.-Dec., 1929, *5*, 939–957.

A table is given showing the kinds and numbers of diseases treated and the kind of treatment given in each—roentgen or radium irradiation, phototherapy, electrotherapy, cryotherapy or roentgen diagnostic irradiation.

In trichophytosis, sycosis of the beard and tinea of the scalp, 2000 cases of which were treated, roentgen epilation is the treatment of choice and is entirely free of danger when given with the proper technique; the bad results are sometimes due to unwise post-irradiation treatment, such as the use of caustics, exposure of the head to the sun or the use of the wrong medical treatment when there is infiltration or suppuration, as often happens in tinea acorina. The author had the best results in psoriasis by using various methods of irradiation. Irradiation of the thymus and thyroid associated with general ultraviolet baths gave brilliant results in young subjects, particularly girls and there have been no recurrences after several years. Some forms of generalized psoriasis were greatly improved by ultraviolet irradiation, particularly old stubborn cases which had resisted all other methods of treatment. The patients should also be given a roentgen diagnostic examination. In one case the author found a sarcoma of the lung in an individual who had had generalized psoriasis for some twenty years; in addition to the psoriasis and poor general condition, he had dyspnea and enlarged spleen.

There is no specific method of treatment for

lupus vulgaris but the author has had the best results from combined irradiation, the treatment being adapted to each case. The general treatment for tuberculosis should be given in association with the radiant treatment. The best treatment for lupus of the mucous membranes is radium. Roentgen examination of the thorax should be made in all cases before treatment; the majority of the cases show active or inactive pulmonary tuberculosis. In one case the author found an echinococcus cyst of the lung that had not caused any symptoms.

Irradiation is not very effective in the local treatment of lupus erythematosus and for some time the author has not treated it either with roentgen rays or radium; in many cases he has had good results by treating the local lesions with cryotherapy and giving total ultraviolet light baths. Recent investigation has shown that this form of lupus too is tuberculous and the patients should be treated in accordance with this fact.

The author has had brilliant results in eczema by irradiating the thyroid, particularly in young subjects with thyroid symptoms. He has had excellent results in eczema of the female genitalia by irradiating the spinal cord or the ovaries, the latter with the so-called stimulating dose or the castration dose for the ovary, depending on the clinical picture.

He has treated 2,252 cases of tumor in all and has reported in a previous article on the treatment of carcinoma of the uterus and vagina. In inoperable carcinoma of the breast he cannot say that he has had complete cure but the tumors have been greatly decreased in size and the life of the patients prolonged. In the cases given prophylactic postoperative irradiation he has not seen any recurrence in five years. In the cases in which recurrences were irradiated there is cure in about 40 per cent after five years; most of the patients were irradiated too late. The technique has to be adapted to the individual case.

The results in sarcoma in general are very good and some forms of osteosarcoma were so greatly improved that they may be considered cured. Osteosarcomas in boys up to fifteen years of age disappear, but recurrence is the rule; even when the recurrences are not evident clinically or roentgenologically the patients die of cachexia. The author has seen some cases of osteosarcoma in young subjects following trauma and he saw 2 cases in soldiers after gunshot wounds. The osteosarcomas in both cases developed in limbs in which there were metal fragments from the wounds. Both of these patients were irradiated and the tumors disappeared but they eventually died of cachexia.

Epitheliomas are the tumors of the skin in which roentgen treatment is most successful. With Ghirlarducci's method of variable filtration the author has had success in 95 per cent of the cases. In the other forms of tumor of the skin he used various methods, among which that of coagulation with diathermia and irradiation has given excellent results.

He has had excellent results from roentgen treatment in various diseases of the eyes, such as keratitis, glaucoma, spring conjunctivitis and some forms of tuberculosis. The treatment of cancers of the larynx, tonsils and pillars of the fauces requires great technical care but the results are good and in some cases there is cure. Irradiation of tumors of the auditory tract and rhinopharynx gives excellent results and the author intends to publish a special report on them. The author is conceived that the radiotherapy of all tumors would give better results if the patients were treated in the hospital and kept under observation for a long time. Roentgen therapy should be considered like a surgical operation and careful preoperative and postoperative treatment given.

He has had excellent results from diathermia associated with roentgen therapy in Heine-Medin's disease, gonorrheal arthritis, postoperative abdominal conditions, neuralgic pain, varices, etc.

Ultraviolet and infra-red irradiation also has good effects in many conditions. Brilliant results have been obtained with ultraviolet irradiation in some forms of skin disease, including recurrent herpes, some forms of eczema and psoriasis. Ultraviolet irradiation also gives good results in some internal diseases, such as some forms of tuberculosis, anemia, etc., and in tuberculous arthritis, orchi-epididymitis, etc. Venereal adenitis if treated early recovers without operation.—*Audrey G. Morgan.*

## ROENTGEN AND RADIUM THERAPY

COLA. Sul trattamento Rontgen-diatermico delle nevralgia. (The roentgen-diathermia

treatment of neuralgia.) *Arch. di radiol.*, Jan.-Feb., 1930, *6*, 284.

The author discusses the results obtained in the treatment of neuralgia by roentgen rays combined with diathermia. His statistics include 38 cases, 15 of neuralgia of the sciatic, 10 of the trifacial, 5 of the brachial plexus, 5 of the intercostals with 2 of herpes zoster and 2 of the femoral. He finds that the combined method gives far better results than diathermia alone and brings about cure in many cases that resist all other methods of treatment. As a general rule, he gives a first series of about ten diathermia treatments, followed by a first cycle of irradiations; if there is no improvement he repeats both series and then gives a rest of a week. In the great majority of cases this is sufficient for cure. The diathermia is of low intensity and the roentgen therapy, of the roots or trunk, in small doses of moderate hardness strongly filtered so as to avoid the reaction that larger doses often cause. In herpes zoster and some forms of neuralgia of the trifacial roentgen therapy alone is sufficient. He obtained cure in 80 per cent of the cases. The results are brilliant in some post-infectious cases; there is rarely recurrence. The author thinks the mechanism of action of the treatment is similar to that of protein therapy, acting directly on the sensory ganglia and nerve trunks and changing the hyperemia and inflammatory infiltration.—*Audrey G. Morgan.*

Luigi, La Ferla. Casuistica di 5 anni di Curie-terapia. (Statistics of five years of radium therapy.) *Arch. di radiol.*, Jan.-Feb., 1930, *6*, 261–268.

The author prefaces his article by saying that he has nothing new to report. It is merely his personal statistics for five years of radium therapy. He has treated 263 patients, 60 with cancer of the cervix, 29 with cancer of the body of the uterus, 37 of epithelioma of the face, 29 of the tongue, 25 of the breast, 12 gland tumors, 11 tumors of the rectum, 8 of the nasal fossae and 7 of the bones, 6 keloids and 6 tumors of the bladder and prostate, 5 of the urethra and external genital organs, 2 fibroadenomas of the cheek, one case of lupus, one of sycosis, and one tuberculoma of the lip.

Among the 60 cases of tumor of the cervix there was no news after treatment in 15; among the other 45 cases, 8 died within a year of the treatment, there was no news of 5 after the first year, 6 died within two years, 10 were well after two years, 9 were well after three years, 6 were well after four years and one well after five years.

Among the 29 cases of cancer of the body of the uterus there were 3 postoperative recurrences, the outcome was not known in 10 cases, 11 patients died within a year of the treatment, 7 are well two years after the treatment. The author never had satisfactory results in postoperative recurrences.

Thirty-seven epitheliomas of the face were treated; 22 of the patients are well after periods varying from five months to five years; there was no result in 7 and the outcome is unknown in 8.

Of the 29 cases of cancer of the tongue, 3 are well after $3\frac{1}{2}$ years, 2 are well after $2\frac{1}{2}$ years, 3 are well after six months, 4 after a year; five recurred after $1\frac{1}{2}$ years, 3 after $2\frac{1}{2}$ years, 2 after 3 years; there was no result because of metastases in 8 and the outcome was unknown in 2.

Among the 25 cases of cancer of the breast, 3 of those irradiated without operation are well after two years, one well after ten months. One patient operated on and irradiated is well after five years. Of the 20 cases of recurrence after operation treated one is well after five years, 2 are well after three years, 2 are well after two years, 2 are well after six years, in 7 there was no result, in 6 there was no news after the treatment, in one there was local recurrence after three years and 1, very sensitive to radium, had multiple metastases at a distance a little while after the treatment. Of the 23 cases of angioma 18 were cured, 3 improved, one died of intercurrent disease during the treatment, one of cavernous angioma of the 9th right intercostal space the size of a nut, resistant to radium, was cured by surgical operation. In the cases of lymphosarcoma there was only temporary improvement.

Among the 11 cases of cancer of the rectum 6 were markedly improved, 3 were not improved and the outcome is not known in 2.

Among the 8 cases of tumor of the nasal fossae 2 were cured after two years and nothing has been heard of them since, in 2 the outcome is unknown, 2 are improved and in 2 there was no result.

Among the 7 bone cases one patient is well $4\frac{1}{2}$ years after the treatment, 3 were greatly improved a year after the treatment and noth-

ing has been heard of them since and in 3 there was no result.

All the 6 cases of keloid were cured. The treatment had very little effect in the cases of cancer of the prostate and bladder; among the 5 cases of cancer of the external genitalia there was no special effect in 3, one patient is still well a year after the treatment and one was well for two years and then had a recurrence which resisted all treatment. One of the two patients with fibroadenoma of the cheek had a local recurrence a year after treatment which was treated and he is still well after two years; the other is well after a year. The one case of lupus was cured and neither radium nor roentgen rays had any effect in the case of ulcerated tuberculoma of the lip.—*Audrey G. Morgan.*

LUCY, A. Au sujet du traitement physiothérapique des sciatiques. (The physiotherapeutic treatment of sciatica.) *Rev. d'actinol.*, Nov.-Dec., 1929, *5*, 691–693.

For the past two years the author has used a combination of roentgen therapy and diathermy in the treatment of all cases of sciatica, with very satisfactory results. The technique of the roentgen therapy consisted in the irradiation of the sciatic roots through two fields directed slightly obliquely from the two sides with 600 R per field (8 mm. Al, 25 cm. spark gap) repeated at intervals of five days until a total dose of 3000 R per field was administered.

The diathermy was applied during the intervals of the irradiation. One lead plate was placed on the gluteal region and the other on the foot. An intensity of from 800 to 1000 ma. was used until the patient complained of an uncomfortable sensation in the region of the ankle, then the electrode was placed on the calf and the intensity was increased to from 1200 to 1500 ma. As soon as the patient complained of disagreeable sensation in the popliteal region the electrode was again changed, this time to the anterior surface of the thigh and the intensity was increased to 2000 ma. (for twenty-five minutes). The duration of the treatment was from one to two months and in only a few instances was it necessary to repeat the treatment.—*T. Leucutia.*

DELHERM, LOUIS, and MATHIEU, PIERRE. Le traitement de la poliomyélite infantile par la radiothérapie. (The treatment of infantile poliomyelitis with radiotherapy.) *Rev. d'actinol.*, Nov.-Dec., 1929, *5*, 683–690.

Ten cases of infantile poliomyelitis which were treated by roentgen therapy are presented in a tabular arrangement. Four were late and 6 were early cases (1½ months) when coming for treatment. Good results were obtained only in the early cases. There was (1) a notable functional improvement as a whole, but (2) when the muscles already showed a state of complete reaction of degeneration the improvement was nil, except in one case in which the total faradic excitability of the extensors of the toes transformed into a hypoexcitability. (3) In cases with only partial reaction of degeneration of the muscles there was often very satisfactory improvement.

The authors have also reviewed 290 cases quoted from the literature and found that in only 15 of these cases was there evidence of a complete reaction of degeneration. Of these 15 cases, in 11 rather favorable results were obtained by the irradiation, no doubt due to the fact that the treatment was started within the first month of the disease.

The conclusion is reached that roentgen therapy is a very valuable therapeutic method in infantile poliomyelitis but it is essential that the treatment be carried out systematically and started as early as possible.—*T. Leucutia.*

ZIMMERN, A., and BRUNET, R. Radiothérapie surrénale dans les gangrènes artéritiques. (Suprarenal roentgen therapy in arteritic gangrene.) *Bull. et mém. Soc. de radiol. méd. de France*, Feb., 1930, *18*, 56–60.

Two cases of rather extensive diabetic gangrene were treated successfully by roentgen irradiation of the suprarenal region. In the first case the gangrene was localized to the palmar aspect of the right thumb and healing was obtained by administration of a cutaneous dose of 2500 R over each suprarenal region. In the second case the gangrene was localized to the dorsal aspect of the foot and the healing was the result of 6 series of roentgen irradiation over the suprarenal regions, each series consisting of 4 seances of 400 R per field, given alternatingly every second day with an interval of from one to six weeks between the series.

The conclusion is reached that the irradiation of the suprarenal region is of considerable value in gangrene due to endarteritis obliterans

and that occasionally a complete healing may ensue.—*T. Leucutia.*

Flaszen, Julius, and Wachtel, Heinrich. Ueber den histiolytischen Effekt bei Radiumbestrahlung von Krebsgewebe. (On the histiolytic effect of radium irradiation in cancer tissue.) *Klin. Wchnschr.*, Dec. 24, 1929, *8*, 2422–2425.

It was observed in connection with 2 cases (a carcinoma of the lip and a carcinoma of the mamma) treated by radium that an early reaction, which developed within eight hours following the treatment and reached its climax within forty-eight hours, resulted in a very rapid reduction in the size of the tumor.

Experiments carried out with malein acid which, as is known, represents the chemical prototype of cancer defense mechanism revealed that irradiation of the malein acid destroyed the inhibitive property of this substance on carcinolysis. This action was found to be chiefly due to the beta rays of the radium.

It is suggested that in a similar manner during the course of irradiation of carcinoma the beta rays, which no doubt are responsible for the early reaction, produce a destruction of the inhibiting substances, thus leading to cytolysis. From a practical standpoint this means that beta radiation ought to be used more extensively in the treatment of carcinoma than hitherto done.—*T. Leucutia.*

Delherm, Morel-Kahn and Desgrez. La roentgenthérapie dans le traitement de la syringomyélie. (Roentgen therapy in the treatment of syringomyelia.) *Presse méd.*, Feb. 26, 1930, *38*, 281–284.

After an extensive review of the literature and a brief consideration of the clinical, anatomico-pathological and pathogenetic aspects of syringomyelia, the authors give a tabular survey of 91 cases collected from the literature which were treated by roentgen radiation. Of these, in 82 cases (about 90 per cent) there was amelioration, in 6 cases (7 per cent) no improvement and 2 cases (2 per cent) remained doubtful. Of an additional 53 cases treated by Keijser there was improvement in 60 per cent.

The authors include 17 of their own cases (all briefly enumerated) in which the following results were obtained: 9 cases (60 per cent) improved; 1 case, no improvement and 5 cases (33 per cent) aggravation. The improvement manifested itself chiefly in the subjective symptoms, while the objective symptoms disappeared more slowly. Some of these as for example the electric reactions, remained unchanged.

The technique of the irradiation was as follows: 25 cm. spark gap, 2 ma., 30 cm. skin target distance, 5 to 8 mm. Al filter, the entire spine being irradiated in sections (with wide overlapping of the normal structures), 1200 to 1600 R being administered per field (in fractions of 400 R given twice weekly) by crossfiring from the two sides of the spine. The intervals between the series showed considerable variation, depending on the degree of improvement. In some instances as much as 24,000 R was administered over the individual fields, extending over a period of many months or years.

The conclusion is reached that roentgen therapy is of great aid in the treatment of syringomyelia and that in a few instances a complete healing may ensue.—*T. Leucutia.*

d'Halluin, Maurice. A propos du traitement du cancer par les radiations de courte longueur d'onde. (Concerning the treatment of cancer with radiations of long wave length.) *J. de radiol. et d'électrol.*, Feb., 1930, *14*, 113–114.

Twenty-five cases of various malignancies which have remained well for a period of from three to nine years are briefly reviewed and in connection with this the following therapeutic principles established: (1) good results are sometimes obtained with moderately large doses; (2) the regional treatment with roentgen rays is advantageously combined with the local application of radium; (3) in half of the above cases no biopsy was taken but this should not lessen the value of the statistics since in many instances biopsy is contraindicated; (4) the superiority of radiation is evidenced by the good results obtained even in advanced inoperable cases. The action of the roentgen rays is chiefly direct; yet the importance of the general systemic reaction should not be underestimated.—*T. Leucutia.*

Monacelli, Mario. Über Spätschädigungen nach Grenzstrahlbehandlung. (Late injuries following treatment with borderline rays.) *Strahlentherapie*, 1930, *35*, 581–591.

Four cases which were treated by borderline rays and which later resulted in rather marked

skin changes are described in detail. One of the cases is illustrated with a colored photograph. The 4 cases were observed in a total of 652 cases, during the past 2½ years.

The conclusion is reached that the borderline rays are not entirely harmless and that one should proceed very carefully with the administration of doses larger than 4000 R.—*T. Leucutia.*

LOVISATTI, N. Il metodo Bordier nel morbo di Heine-Medin e gli effetti a distanza di tempo delle radiazioni. (The Bordier method in Heine-Medin's disease and the late results of irradiation.) *Arch. di radiol.*, Sept.–Oct., 1929, *5*, 897–902.

In 1911 Bordier began to treat a patient with progressive muscle atrophy of the Aran-Duchenne type with roentgen therapy and brought about permanent cure in this and in 2 other cases treated in the same way. He then began to treat anterior poliomyelitis with roentgen irradiation combined with diathermia and electrotherapy. The Bordier method has not been very generally accepted though some good results have been reported from it. Berghinz among 55 cases treated with this method had 15.5 per cent cures, 75 per cent improvements and no effect in 9.5 per cent. Chizzola among 62 cases had 23 complete cures, 11 cures with slight residues of muscle weakness, 10 marked improvements, 9 slight improvements, and 9 cases in which there was practically no effect. This is 27 per cent complete cures.

From the end of 1924 up to the present time the author has treated 97 cases of Heine-Medin's disease with the Bordier method. He used 400 French R at a treatment, 35 cm. spark gap, 0.5 mm. zinc filter on one or two fields about 6×8 cm. in area, the size depending on the extent of the lesions. A treatment was given every week for five or six weeks. Diathermia and electrotherapy were associated with the roentgen therapy according to the indications. His proportion of cures and improvements was about the same as those of Berghinz. He thinks this is the most encouraging treatment yet tried for infantile paralysis and, as with other treatments, the earlier the treatment is begun the better the results. He has reexamined the patients after varying periods of time up to as long as four years to see if there were any lesions of the skin, bones or spinal cord, as the objection has been made to the treatment that such injuries might occur in young children. But he was not seen any such lesions and concludes that with the doses ordinarily used there is no danger of interference with the later development of these or other structures.—*Audrey G. Morgan.*

BAILY, PERCIVAL. Further comments on the cerebellar medulloblastomas; the effect of roentgen radiation. *Am. J. Path.*, March, 1930, *6*, 125–135.

Several cases are added to those previously reported all of which cases have been treated surgically as well as with roentgen radiation. In spite of the fact that the tumor cells are radiosensitive all of these cases have died, usually with an intraspinal or intracranial extension of the tumor. This extension is more common after operation and is thought to be due to scattering of tumor cells in the cerebrospinal fluid.—*P. A. Bishop.*

BERETVAS, LEOPOLDO. Sullo xeroderma pigmentosa e la sua importanza per la questione della ipersensibilita individuale di fronte ai raggi e della patogenesis dei tumori. (Xeroderma pigmentosum and its relation to the question of individual hypersensitiveness to rays and to the pathogenesis of tumors.) *Arch. di radiol.*, Jan.–Feb., 1930, *6*, 245–250.

Xeroderma pigmentosum generally begins at the age when the child is first exposed to sunlight. While a normal child shows only a slight temporary reaction a child predisposed to xeroderma shows an inflammation which results in xeroderma pigmentosum. Finally tumors develop and generally cause the death of the patient. These facts led the author to experiment with a case to see whether the skin of xeroderma patients contained substances that sensitized to ultraviolet rays and whether there is any relation between inflammation caused by rays and the development of tumor. His results were negative but he thinks the fact of xeroderma pigmentosum shows that there is an individual hypersensitiveness to rays and that as a matter of precaution any irradiation should be begun with a small dose to test the sensitiveness of the patient.—*Audrey G. Morgan.*

GOUIN, J., AND BIENVENUE, A. L'action des rayons X sur le sympathique est-elle un fait nouveau? (Is the action of roentgen rays upon the sympathetic a new fact?) *Bull. et mém. Soc. de radiol. méd. de France*, March, 1930, *18*, 127–132.

After a detailed review of the development of the roentgen therapy of the sympathetic system, the author establishes the present indications as follows: (1) axial roentgen therapy (*a*) without filter, chiefly for skin lesions; (*b*) with light filtration, for splanchnic effect; (2) regional roentgen therapy (vascular nerve bifurcations), for vasomotor effect; (3) local roentgen therapy, for local and occasionally distant effect, and (4) organic roentgen therapy (suprarenals, etc.), for the effect on the sympathetic system. These conclusions are based on eleven years' experience, the treatment of several hundred cases and 25 publications.—*T. Leucutia.*

Nicolas, J. Épithélioma de Roentgen ulcéré guéri en une seule séance par la diathermocoagulation. (Ulcerated roentgen epithelioma healed in a single seance by diathermocoagulation.) *Presse méd.*, May 7, 1930, *38*, 631.

This is a short description of the author's own case and experience in the treatment of a roentgen epithelioma by diathermo-coagulation. The epithelioma (2 cm. in diameter) was located at the outer and posterior aspect of the second phalanx of the right third finger, producing a central ulceration of 6 mm. in diameter. Following one single electrocoagulation there was rapid healing and within two months there was a return to normal. The photographs of the hand before and after treatment are included. The method is highly advocated.—*T. Leucutia.*

Maino, Mario. Modificazione alla tecnica degli apparecchi radiferi di superficie. (Changes in technique of making apparatus for the superficial application of radium.) *Radiol. med.*, Feb., 1930, *17*, 109–125.

It has been very hard to find a good support for the application of radium to the surface. The large number of substances now in use shows that no really satisfactory one has been found.

The material used for making the apparatus must be absolutely malleable within certain maximum and minimum limits of temperature. The apparatus must be as light as possible so as not to tire the patient too much. The apparatus should be uniform in thickness and the material used in making it must be absolutely impermeable. The material should be a good filter for the therapeutic rays and should not emit any injurious secondary rays and should help to make the irradiation as homogeneous in distribution as possible.

The technique proposed by Sluys with an apparatus made of celluloid with a wooden framework is complicated and difficult. Columbia paste is too fragile and its form too easily changed when it is thin and it is too heavy when made thick enough to be solid. Nogier's wool felt and Mallet's tarlatan are not solid enough because of the softness of the mixture of wax and paraffin that they use. The author therefore proposes using hygroscopic cotton soaked with paraffin. The paraffin is hard enough to make the apparatus solid and the cotton serves to keep it from being too fragile. The apparatus is cleaner and lighter than the others in use and does not change form so readily. Supports may be incorporated in it if necessary. It can readily be adapted to the parts of the body on which it is to be used.—*Audrey G. Morgan.*

Turano, Luigi. Lo studio capillariscopico dell'eritema da raggi Roentgen. (Study of roentgen erythema by means of capillaroscopy.) *Radiol. med.*, Feb., 1930, *17*, 139–149.

The technique of the method of capillaroscopy has been described in a previous article. Roentgen erythema observed by this method shows alternations of vasodilatation and vasoconstriction which have an irregular rhythm that probably cause the waves of redness described by Miescher. The time of beginning, frequency and duration of these alternations depend chiefly on the constitution of the subject under examination and on the dose given. The capillaries are not permanently injured but only temporarily irritated. About two months after an erythema dose has been administered, there is complete restoration to normal. These changes in the capillaries always precede the macroscopic changes in the skin. This early reaction is only a manifestation of an intense temporary irritability of the walls of the capillaries. It is the first sign of a beginning erythema. The capillary reaction always begins within a few hours of the irradiation and sometimes immediately after it. The author thinks that this course of the erythema shows that the capillaries have nerves of their own on which the irradiation acts directly and which gives them an independent motility of their own; but

these nerves are correlated with the general vegetative nervous system.—*Audrey G. Morgan.*

VISCHIA, Q. La fisioterapia nell'angina pectoris. (Physiotherapy in angina pectoris.) *Radiol. med.*, Feb., 1930, *17*, 158–166.

Surgical treatment has been used in angina pectoris to relieve the pain but it would seem from recent work that this can be accomplished as effectively by radiotherapy. It probably acts by vasodilatation, thus improving the coronary circulation which is without doubt affected in angina pectoris. Marchal says that radiotherapy causes decreased sensitiveness of the sympathetic and does not cause any changes in the heart muscle, as shown by electrocardiographic tracings, when given in therapeutic doses. Lewis had excellent temporary results and Barrieu and Nemours brought about permanent improvement in their patients with three irradiations per week, distributed over one anterior field (second left intercostal space) and two posterior fields (from the 1st to 6th cervical and from the 7th cervical to the 6th dorsal). Arillaga had good results with roentgen therapy in 8 cases; Lian, Barrieu and Nemours had 26 successes in 30 cases; Marchal presents statistics in which he had 87 per cent successes and 13 per cent failures. Nemours and Barrieu in 51 cases of angina pectoris given roentgen treatment found that the pain stopped in 31 and was improved in 9; the results were negative in only a few cases; 6 of the patients died. There is some question as to whether roentgen irradiation has any bad effect on the heart muscle. Orndorff irradiated a man with carcinoma of the lung with large doses and did not find any changes in the heart on autopsy. Hartman, Bolliger, Doub and Smith have reported injury of the myocardium in animals from roentgen irradiation but they used very large doses. Some caution should therefore be exercised in giving roentgen treatment, particularly in patients with serious insufficiency of the heart. The roentgen treatment may be repeated when the pain recurs and in some cases transthoracic diathermia may be used to improve the coronary circulation. Pelnar has used intravenous injection of 20 c.c. of physiological salt solution containing 5–6 mc. radium; the injections are given into the left ulnar vein (1–3 injections a week), but may also be given subcutaneously; the whole treatment consists of 6 injections. A number of authors report good results from transthoracic diathermia. Ultraviolet rays have also been used and Hasselbach and Jacobaeus report irradiations with a carbon arc light in 44 cases with only one failure.—*Audrey G. Morgan.*

TORELLI, G. La roentgenterapia dell'asma bronchiale. (The roentgen therapy of bronchial asthma.) *Radiol. med.*, Jan., 1930, *17*, 16–37.

The author describes 3 cases in which he treated bronchial asthama with the following technique: 155 kv., 3 ma., filter 0.5 mm. copper and 3 mm. aluminum, irradiations twice a week over the thorax, spleen and liver. Three thoracic fields, one anterior 15×15 cm., focus-skin distance 40 cm. (amount of radiation at a depth of 10 cm., 38.5 per cent), and two posterior fields measuring 8×10 cm., with a focus-skin distance of 30 cm. (amount at 10 cm., 30 per cent), using a slight median inclination of the tube for these fields; two splenic fields with a cylindrical limitator 7.5 cm. in diameter, focus-skin distance 37 cm. (amount of radiation transmitted 27 per cent), and one liver field with a cylindrical limitator 10 cm. in diameter, focus-skin distance 37 cm. (amount transmitted 31 per cent); at each treatment two fields were irradiated, one pulmonary and one splenic or hepatic one, with a dose of 15 to 20 per cent S.U.D. at the surface for each field.

Two of these cases were beyond doubt greatly improved; it is hard to say whether they are permanently cured, though there have been no recurrences of the attacks in the five months that have passed since the treatment. The third case was a complete failure and the author thinks this was because the asthma was complicated by emphysema. So while there are no true contraindications to roentgen treatment in asthma, it is not to be particularly recommended in cases complicated by emphysema. It is particularly indicated in cases in which the cause cannot be found and therefore a specific desensitizing treatment cannot be given, and in cases in which in spite of specific desensitizing treatment there are enlarged glands, endocrine changes, etc. The action of the rays may be due to the fact that they reduce the swollen tracheobronchial glands, that they have a regulating action on the endocrine glands or that they have a nonspecific desensitizing action, similar to protein therapy, produced by slight repeated

shocks caused by substances produced by decomposition of the cells by the roentgen rays being set free in the blood. The rays also produce a soil favorable to the production of shock by causing disequilibrium of the vegetative nervous system in the direction of vagotonia. —*Audrey G. Morgan.*

Vigano, E. L'applicazione dei raggi limite in alcune dermatosi. (Use of borderline rays in some dermatoses.) *Radiol. med.*, Jan., 1930, *17*, 37–49.

The author describes Bucky's method of producing what he calls his borderline rays, though they are not really the extreme limit of the roentgen scale. He calls them this because they produce reactions in tissues that are not produced either by roentgen or ultraviolet rays. They have only slight pepentrating power and do not even reach the papillary layer of the skin in sufficient amount to cause the hair to fall out.

The author describes 43 cases of various kinds of skin disease in which he used these rays, including hyperkeratotic eczema of the palms, basal cell epithelioma, pruritus of the vulva, keloid, acne of the nape of the neck, tinea favosa, neurodermatitis, psoriasis, chronic wounds, lupus vulgaris, etc. He describes the technique and the doses used in the different cases. The number of cases treated is too small and the time since treatment too short to be able to pass definite judgment on the results. But the author thinks that the improvements and the cures obtained show that these rays, like roentgen rays, have a good effect in certain dermatoses. But they do not act constantly and with the same intensity in all cases. Sometimes even their action seems to be less intense and less prompt than that of roentgen rays. The changes which the author found in the leucocytes in the patients treated with borderline rays and the decrease of erythrocytes in a patient with polycythemia treated by irradiating the spleen with these rays indicate that they, as well as roentgen rays, have not only a local but also a general action. The author thinks that the relative harmlessness of these rays is not a reason for preferring them to the roentgen rays as the dangers from roentgen rays have now been mostly overcome by proper technique. It will require further work to show whether they give prompter and better results in dermatoses than roentgen rays.—*Audrey G. Morgan.*

Brown, William L. Multiple-area intra-uterine irradiation: preliminary report. *J. Am. M. Ass.*, May 10, 1930, *94*, 1471–1475.

Radium is used within the intrauterine cavity in the treatment of hemorrhage, malignant growths, fibroids, polyps, papillomas, and endometritis. Homogeneous and diffuse irradiation is essential in all these conditions. The author states that the present-day applicators do not provide this type of irradiation. He states that multiple-area irradiation of the uterus provides more homogeneous irradiation and also distributes the dosage over the uterine cavity instead of limiting it to one point, with the danger of producing radium necrosis at this point. Packing the cervical canal does not permit drainage of secretions and with contraction of the uterus on a foreign body, these may be forced into the abdominal cavity. Also, overdosage of a single area increases the secretions.

The author states that the T-applicator is beneficial and affords cross-fire irradiation, but its rigidity does not permit its insertion into a distorted uterine canal.

The multiple-area applicator, which the author has designed, he believes has overcome many of the difficulties described above. It provides for one, two, or three intrauterine radium tubes. The radium capsule is in a brass tube, 1 mm. thick, which is at one end of a calibrated carrier, the proximal portion of which is of clock spring steel to permit flexibility. The lateral carriers are curved laterad, while the central carrier is flexible in all directions and curved slightly anterior. All three carriers pass through a brass tube with a disk on one end that fits against the cervix, through which the carriers and radium tubes protrude into the cervical canal, and then into the uterine cavity. The distal end of the brass tube protrudes from the vagina and is arranged with a collar and eyelets so it can be fastened in place to a T-binder. A set screw on the collar also holds the carriers in place.

In applying the applicator, the operator dilates the cervix and introduces a sound to determine the depth. Then the central carrier is introduced, followed by the two lateral carriers. The three carriers are then brought together with the brass cylinder, which is slipped over them until the proximal disk fits up against the

cervix. The set screw on the collar of the distal end is tightened on the carriers. The vagina is then packed and a T-binder is applied to which the applicator is fastened to hold it in place. The position of the tubes may be changed by loosening the set screw and pulling out the carriers to the desired position.

Irradiation may be carried out at more than one level by this method.

The author has included illustrations which are roentgenograms of the applicator in place and diagrams of the applicator.—*Vincent Johnson.*

WOOD, FRANCIS CARTER. Roentgen treatment of uterine fibromyomas. *J. Am. M. Ass.*, Mar. 1, 1930, *94*, 601–606.

Great divergence of opinion exists as to the proper treatment that should be used in uterine fibromyomas. Hard, necrotic or calcified myomas should be removed surgically, also those complicated with cystic disease of the ovary, or acute or chronic inflammatory processes of any type. Pregnancy cannot always be excluded. There is a great difference in opinion as to when ovaries should be removed or left. Supravaginal hysterectomy has been questioned because of the possibility of carcinoma developing in the cervix which is left. There is some difference of opinion about pedunculated submucous or subserous myomas. These are difficult to cure by irradiation. Sarcomatous degeneration of the fibroid is infrequent; in this country most surgeons remove them; in Germany, irradiation is extensively used. Corpus carcinoma may complicate fibromyomas and unless diagnosed, the patient will not be treated properly. According to the author's experience, complications of other pathologic changes in the adnexa are not frequent. The mortality of hysterectomy at St. Luke's Hospital is 1.5 per cent in the last 1000 cases. There is no mortality with irradiation. An occasional case is reported in which the os is stenosed with resulting pyometra, obstruction of the uterus or perforation of the intestine. It is necessary for the intestine to be adherent to the uterus to receive an overdose.

In young women the use of radium in 1000 to 1500 mg-hr. is of advantage as it may preserve menstruation, and subsequent offspring may be possible.

In balancing the results of treatments, it is apparent that the advantages of surgery are its certainty in removing the fibroid, the possibility of avoiding sterilization in young women by myomectomy or partial hysterectomy; the relatively low mortality, and the possibility of handling other pathologic conditions at the same time.

Against surgery, may be placed the mortality, the slow convalescence, the necessary expense, the abdominal scar with development of a keloidal hypertrophy or ventral hernia.

On the side of irradiation, radium being considered first, most fibroids will shrink and disappear with a single treatment of 1500 mg-hr.; menstruation may reappear after a short period of amenorrhea and patient may become pregnant.

The disadvantages are: the use of radium necessitates hospitalization; the mucous membrane in contact with the radium may become atrophic; post-irradiation sickness may occur; permanent menopause.

The advantages of roentgen treatment are: the patient is ambulant; the treatments are infrequent and short; the patient rarely has irradiation sickness; the effect is chiefly on the ovaries; the cost is minimal.

Patients between twenty-five and forty require slightly heavier dosage and more prolonged than those from forty on. Many cases from fifty on require only 3 or 4 treatments.

The dosage suggested is from 60 to 75 per cent of a skin erythema, with voltage not exceeding 160 kv. and a filter of 0.25 mm. of copper or 0.5 mm. of zinc. The patient receives such a dose not oftener than once in ten days.

The author discusses other factors relative to the successful handling of the patient and referring physician. The paper is an excellent one. It was discussed by Drs. Schmitz, Pfahler Ullmann, Soiland and Orndoff.—*E. P. Pendergrass.*

KAPLAN, IRA I. Post-radiation pregnancy. *Surg., Gynec. & Obst.*, Feb., 1930, *50*, 492–493.

Permanent amenorrhea in young women is not certain to be produced with roentgen rays. Not all ova may be destroyed by roentgen castration in young women and ova not destroyed may ripen, become impregnated and develop normally. One case treated with unstated factors following amenorrhea of unstated length of time became pregnant less than a year after treatment and had a child which in fourteen

months has shown no abnormality.—*G. R. Miller.*

Bloodgood, J. C. Radiosensitive tumors and tumors that first should be subjected to operation. *Radiology*, 1930, March, *14*, 254–262.

Bloodgood believes that in the early stage of all tumors and local lesions, both theoretically and practically, whether there is to be an operation or not, it is wiser, with certain exceptions, to try radiation first, either with roentgen rays or with radium. More recent experience has indicated that any operation which incompletely removes the tumor locally, produces conditions that make secondary irradiation less valuable. It is the author's opinion that no harm is done by subjecting a subcutaneous nodule to irradiation first, except when it is situated in certain localities, as in the breast and thyroid gland, where experience favors operation first. If a bone tumor is distinctly malignant, there is a choice between immediate operation (resection or amputation), or trial of irradiation first. His figures show that amputation and resection have accomplished permanent cures in 35 per cent. However, he feels that more bone lesions should first be subjected to irradiation. Biopsy should be reserved for the last resort and, if possible, should be followed immediately by amputation or resection. There is an increasing percentage of permanent cures in sarcoma of bone, both after amputation and after irradiation. When the roentgen and other diagnostic studies allow the conclusion of a benign tumor, it is a waste of time and money to use radiation, except in the giant-cell group. He is rather inclined to the opinion that in cases of giant-cell tumor not suitable for immediate curetting, and in all other cases in which there is not a rapid reaction to irradiation, if the lesion can be removed by resection and bone transplantation, the latter should be the treatment of choice.

Bloodgood has found that nerve sheath tumors, whether benign or malignant, are often radiosensitive, especially in the early stage, and they should be subjected to irradiation before operation, to avoid recurrence by particles of the tumor being left after shelling out or enucleation. Rapid growth of a tumor of the soft parts, whether of recent or old origin, is an indication for immediate irradiation, and if there is not corresponding and immediate checking of the growth, or its disappearance, operation is indicated. An angioma small enough to be excised completely without mutilating can receive this treatment at once. All other angiomas should be given the benefit of as long a course as possible of irradiation. If this fails, he recommends operation. When there is recurrence after excision, whether the tumor had been previously irradiated or not, irradiation should be given another trial. With few exceptions nothing is lost by trying irradiation first when there are single or multiple enlargements of the glands in the axilla, neck and groin. In cancer of the breast Bloodgood reserves irradiation for those cases in which there are signs of metastasis before or after the operation. Its greatest value is in the relief of pain, especially in metastasis to the region of the vertebrae. Chronic cystic mastitis shows the same percentage of spontaneous recoveries, whether treated with irradiation or not. When the lesion of the breast is clinically malignant and very extensive, it would seem best and even definitely indicated, to try some form of irradiation first, but he advocates surgery in all early and operable lesions. Cases of Paget's disease of the nipple can often be cured by simple cleanliness, and it seems dangerous to try irradiation for irritation of the nipple as it may put off the operation when the lesion is malignant. For irritations of the skin that do not disappear quickly under soap and water, Bloodgood believes proper surgery promises greater certainty of cure than any other method. In cases which have locally passed the stage of excision, irradiation should be tried first. All tumors of the skin are best removed by surgery. The metastasis from a malignant mole is rarely if ever influenced by irradiation; nevertheless, it should be tried, as this is the only treatment that offers anything.—*J. D. Camp.*

Desjardins, Arthur U. Osteogenic tumor: growth injury of bone and muscular atrophy following therapeutic irradiation. *Radiology*, March, 1930, *14*, 296–307.

The author states that in the adult body the relative resistance of bone to irradiation is almost as great as that of the brain and nerve tissue, but an excessive single or total dose of roentgen or radium rays may cause injury to bone. Adult bone can tolerate relatively large doses of radiation, but the rapidly growing osseous structures of young animals are

influenced deleteriously even by small doses, the retardation in the growth of bones and other structures in the region exposed to the rays being governed by the age of the animal and the dose of radiation. A brief review of the experimental and clinical evidence in the literature is given which shows that sufficient doses of roentgen or radium rays may cause serious injury to bone.

One of the author's own cases is reported which shows clearly that irradiation of the rapidly growing bone of a nine-year-old child can retard its growth or permanently injure it according to the total dose of irradiation, but it also shows that the growth of the muscles and other structures irradiated may also be greatly impeded. It is clear that while irradiation had caused the malignant tumor in the bone in this case to retrogress, and although such retrogression appeared to be complete, yet the reparative efforts of the bone had been modified considerably by irradiation.—*J. D. Camp.*

WIDMANN, B. P. Radiation technic for cancer of the mouth with combinations of gamma radium rays and varying qualities of high voltage roentgen rays. *Radiology*, March, 1930, *14*, 197–206.

Widmann states that the value of roentgen ray and radium in the treatment of early cancers, particularly early cancers of the skin and mouth, and more particularly the early epidermoid cancers of the cervix, is incontestible. The success of the radiation treatment of intraoral cancer depends, however, upon the degree of radiosensitivity of the lesion, which is noted by rapid responses to radiation as well as histologically by the degree of cellular differentiation—the more highly cellular, the more highly malignant, and, conversely, the more radiosensitive. In his experience more than 60 per cent of mouth cancer cases had advanced local and gland involvement at the beginning of treatment, and unless some definite radical technical procedure can offer a further improvement in the end-results of these advanced cases and the early resistant cases, then irradiation results must continue to be evaluated in the light of "palliative benefits." It is generally agreed that intraoral cancer is best managed by irradiation (roentgen ray or radium or both), and sometimes in conjunction with surgery, particularly when there is gland involvement. The author routinely irradiates both sides of the neck in all intraoral cancers, with or without gland involvement. A single firm and freely movable gland is occasionally subjected to a simple excision, but only if it resists intensive cervical irradiation or develops after apparent adequate cervical irradiation.

Widmann believes that improved results in the radiation treatment of advanced cancer of a resistant type will necessitate the administration of still greater quantities of radiation. The use of additional radiation must depend upon short wave length rays, because of their greater penetrative properties, with a definitely increased skin tolerance. The tissue tolerance is still greater with combinations of short wave length rays. No elective action of different types of rays in conceded. Various treatment procedures are discussed. A description is given of an assortment of stock radium containers and methods of application to meet the requirements of a lesion in any part of the mouth. By external and contact surface irradiations alone, 5 to 8 erythema doses can be administered through the center of the tongue. Radium filtrations, with densities equivalent to 2 mm. of platinum, are advocated. This is approximately two and a half times greater than the usual filter of 2 mm. of brass.

The author concludes that the success of the radiation treatment of advanced cancer will depend upon such technical procedures as will eliminate dependence for good results on the so-called "caustic effects." Clinical impressions indicate that combinations of short wave length radiation will improve the end-results in advanced and resistant types of intraoral cancer. —*J. D. Camp.*

SCHMITZ, HENRY, and HUEPER, WILLIAM. Histological structure, clinical grouping, and prognosis of cancer of the uterine cervix and the breast. *Radiology*, March, 1930, *14*, 223–231.

A description of the determination of the histological malignancy index and the classification of the clinical groups based on the extent of the carcinoma is given. Clinical Group 1 comprises a cancer growth clearly localized within the cervix or a clearly localized, freely movable growth in the breast. Clinical Group 2 indicates a growth which has extended to the periphery of the cervix in a longitudinal or transverse direction, or a single node in the breast which is still freely movable but which

has produced metastases either in the breast or lower axillary lymph nodes, and primary multiple tumors as observed after chronic cystic mastitis. Clinical Group 3 includes those cases in which either one or both parametria or the regional lymph nodes have been invaded, or those cases of carcinoma of the breast in which the tumors have become adherent to the skin or fascia or both. Clinical Group 4 includes carcinomata of the cervix with absolute fixation, or carcinomata of the breast in which the tumor has either permeated the entire skin with ulceration, or has become fixed to the chest wall, or has produced fixed metastases in the upper axillary lymph nodes, or has invaded the supraclavicular lymph nodes, or caused multiple invasions of the skin. The cases are grouped as to malignancy on an average value of 56. Malignancy Group 1 includes cases from 32 to 44; Malignancy Group 2, from 45 to 56; Malignancy Group 3, from 57 to 68, and Malignancy Group 4, from 69 to 80.

The histological malignancy indices were determined in 225 cases of carcinomata of the uterine cervix and 136 cases of carcinomata of the breast. The end-results were known in 100 cases of cervical and 71 cases of mammary cancers. The prognostic value of the histological malignancy index was tested against the end-results obtained. The result is that the malignancy increases with an increase in the value of the malignancy index. In Malignancy Group 1 the good end-results were 100 per cent in breast carcinomata and 80 per cent in cervix carcinomata. In Malignancy Group 2, the good end-results were 60 per cent in breast cancers and 50.7 per cent in cervix cancers. In Malignancy Group 3 the good end-results were 37.5 per cent and 25.8 per cent respectively, while in Malignancy Group 4 good end-results were not obtained in a single instance. The clinical grouping gave relatively similar values. The five-year good end-results in Clinical Group 1 were 69.23 per cent in breast cancers and 78.27 per cent in cervical cancers. In Clinical Group 2 they were 51.72 and 31.68 per cent respectively; in Clinical Group 3 they were 11.77 and 12.42 per cent respectively, and in Clinical Group 4 they were 3.23 per cent and 0 respectively. The study of the degree of histological malignancy and the extent of the growth gives valuable data in the prognosis and treatment of carcinomata of the breast and uterine cervix.—*J. D. Camp.*

Arons, Isidore. Radium and x-ray therapy as palliative measures in the treatment of rectal cancer. *Radiology*, March, 1930, *14*, 232–239.

Arons mentions the four common types of adenocarcinoma of the rectum: (1) the papillary carcinoma, (2) the malignant adenoma, or adenoma destruens, (3) the colloid or gelatinous carcinoma, and (4) the scirrhus or fibrocarcinoma, stating that the two last named are rather radioresistant. A discussion of the lymphatic drainage of the rectum is given, inasmuch as this knowledge is essential in order to place properly interstitial foci of radon. An early biopsy, with histologic grading of the tumor, is of aid in the determination of the radiation procedure. In cases considered inoperable the author notes that the patient's tolerance and health should be conserved by a prolongation of the period of irradiation over several weeks, using interrupted and weak treatments repeatedly to secure growth restraint and induce abortive fibrosis in the cancer. When a curative effect is planned, all the radiation treatment should be given within eight or ten days.

Arons recommends colostomy before the rectal cancer is irradiated. He also states that radiologists must appreciate the necessity of laparotomy, as this affords one of the best avenues for the insertion of radon seeds into the primary tumor as well as into any outlying metastases to lymph nodes. His procedure is to give a pelvic cycle of roentgen irradiation two weeks after the colostomy, followed almost immediately by interstitial radium therapy. He describes his technique in detail.—*J. D. Camp.*

Healy, William P. Carcinoma of the cervix. *Radiology*, March, 1930, *14*, 217–222.

The plan of treatment of carcinoma of the cervix followed at the Memorial Hospital, New York, has consisted of a combination of radium at the site of the primary lesion and roentgen radiation applied through multiple foci about the pelvic girdle. The thought underlying this is the desire to irradiate, as intensively as possible, both the lesion and the lymphatic drainage area about it, in order to control not only the primary disease but also the inevitable parametrial metastasis. A diagram is shown which indicates that a minimum of 100 per cent and a maximum of 120 per cent of a skin erythema dose is distributed throughout the greater portion of the pelvis. Another illustration

shows the total value of the combined irradiation with radium and roentgen rays, as applied at different points, with relation to the source of radiation. The lowest value indicated is 335 per cent of a skin erythema dose and is obtained 5 cm. from the capsule in the cervix. Also, of the total radiation received at this point 30 per cent is attributable to roentgen rays, whereas a point 1 cm. distant from the cervical capsule receives 5,690 per cent of a skin erythema dose, of which only 2 per cent is of roentgen-ray origin and 98 per cent is derived from radium.

The routine procedure in favorable cases has been radium first, followed promptly by roentgen irradiation; the latter cycle is repeated once or twice at intervals of six to eight weeks after the first cycle. The cycle consists of five exposures, four of which include the entire circumference of the pelvic girdle, the fifth being centered posteriorly over the spine of the third lumbar vertebra and is given for its effect upon the prevertebral lymph glands in this area. Cases presenting a large, infected, ulcerated lesion in the cervix receive roentgen treatment before the radium is given. Recently application of radium has been omitted from the first series of treatments. They are reserved for use three or more weeks after the primary series of treatments with roentgen rays and radium has been finished. It has been found necessary to use interstitial or buried radiation as a routine part of the after-treatment in only a small percentage of the cases.

The author emphasizes that the most important factor in prognosis, regardless of the method of treatment employed or the histologic structure, is early diagnosis. Recurrences are seen in the parametrial lymph glands in the sixth, seventh and eighth year after treatment. Local recurrences in the cervix after the fifth year are, however, quite unusual. Reviewing his cases treated with radium and low voltage roentgen rays in 1922, 1923 and 1924, the author reports 44.5 per cent five-year clinical cures in the group of early and borderline cases. —*J. D. Camp.*

KEENE, F. E., and KIMBROUGH, R. A. JR. Fibromyoma uteri, treatment and end-results. *Am. J. Obst. & Gynec.*, Aug., 1930, *20*, 198–208.

The authors present an analytical study of 254 consecutive cases of myoma uteri. They belive that cases with small symptomless tumors need only close observation and did not include such cases in their series.

The usual symptoms were menorrhagia (62.7 per cent), metrorrhagia (9 per cent), lumbar or sacral backache (27.1 per cent), and pressure symptoms (29.4 per cent).

They believe that the treatment of choice should be governed by definite rules, i.e., the ideal case for radium therapy is one in the fifth decade of life that has a tumor not larger than a three months pregnancy, the only symptom of which is profuse menstruation.

The contraindications to the use of radium are: (1) tumors larger than a three months pregnancy; (2) rapid increase in size, indicating either sarcomatous or benign degeneration; (3) pressure symptoms, diminution in size by radium being too slow; (4) tumors associated with pelvic pain; (5) pedunculated tumors, either subperitoneal or submucus; (6) profound anemia; (7) uncertain diagnosis, the prime requisite of successful irradiation being accuracy of diagnosis; (8) stenosis or blockage of the cervical canal; (9) presence of marked secondary anemia in association with a tumor not giving rise to sufficient bleeding to account for the anemia; (10) tumors in young women—irradiation of sufficient dosage to affect the tumor will be followed by premature menopause and sterility; (11) extremely nervous patients, and (12) radiophobia, it being the experience of the authors that when radium was used in these cases in spite of the patients fear of it, although the pelvic lesion was relieved, subsequent ills may be erroneously ascribed to radium's lasting effects.

Radium was used in 21.4 per cent of this series. It should not be used without preliminary diagnostic curettage to rule out malignancy or early pregnancy. They have found 600 to 900 mg-hr. sufficient to control bleeding in most cases.

Roentgen therapy was used in only 4.7 per cent of cases, those with either large or small tumors associated with chronic adnexal disease, who are poor operative risks because of profound anemia. There were no deaths following irradiation.

In 73.2 per cent operations of choice were used, with entirely satisfactory results in 92.5 per cent of cases. The operative mortality was 2.15 per cent.

They conclude that irradiation is not a competitor of surgery, that each has its place.—*P. A. Bishop.*

Davis, Carl H., and Stevens, G. W. Value of routine radiographic examinations of the newborn, based on a study of 702 consecutive babies. *Am. J. Obst. & Gynec.* July, 1930, *20*, 73–76.

A total of 702 infants were examined roentgenographically. Forty per cent, or 319, were normal from a roentenographic point of view. Of the remaining 383 cases showing some abnormality, 229, or 32.6 per cent, showed enlarged thymus, 184, or 26 per cent, showed abnormal lung findings and in 108, or 15 per cent, there was an abnormal appearance of the heart.

The criterion of Wasson was used as a basis in judging thymic enlargement. Only 20 of the 229 cases had thymic symptoms and were treated by roentgen radiation. The enlargement was more common in babies born between March 1 and May 31.

Of the lung abnormalities, 84 showed atelectasis and 38 others poor aeration of the lungs. The cases with variations in the heart shadow are not compared with the clinical findings. Four cases showed evidence of rickets, none of congenital syphilis.

The conclusion was that routine roentgen study of infants presents interesting data but that at present the expense does not justify its introduction as a routine procedure.—*P. A. Bishop.*

Hazen, H. H. Coincidences in medicine. *Arch. Dermat. & Syph.*, Aug., 1930, *22*, 305–306.

A case is reported in which three roentgen treatments, totaling less than an erythema dose with a standardized machine, were given over a small area of the scalp of a young woman, the diagnosis being neurodermitis. Three and a half months later the patient returned with a bald spot roughly coinciding with the treated area. The area showed a number of short stubs characteristic of alopecia areata and ultraviolet treatment was begun but no new hair returned for ten weeks (five months after the last irradiation). It is felt that the alopecia areata occurring after the irradiation was a pure coincidence. —*P. A. Bishop.*

Meigs, Joe V., and Parker, Frederic, Jr. The effect of radium on cancer of the cervix. *New England J. M.*, Aug. 7, 1930, *203*, 247–253.

This is a preliminary report of an effort to determine why radium treatment of certain cases of carcinoma of the cervix are successful while others are not, and whether radium should be used in single large doses or in small divided ones. Five advanced cases were studied clinically and histologically following radium treatment.

Daily biopsies, the first taken before treatment was started, were done until no more tumor tissue could be obtained. The cases fell into two groups, those in the first showing a marked rise in the number of mitoses on the third or fourth day, while those in the second group showed no such change.

The patients in the first group were all dead at the end of thirteen months while those in the second group are well over two years and five months.

It is suggested that the difference in type of reaction following irradiation may possess some significance as regard prognosis and possibly indicates the need of further investigation with regard to a change in the method of treatment. —*P. A. Bishop.*

Knox, Leila Charlton. Radiation therapy of tonsils. *J. Am. M. Ass.*, Mar. 8, 1930, *94*, 705–710.

A report on the effect of irradiation of tonsils based upon experience derived from a series of 259 patients. There is some reference to the literature concerning the experience of others with this method of treatment; also a presentation of results derived from tonsillectomy for the relief or prevention of specific conditions such as arthritis, cardiac disease, recurrent pharyngitis and the effect upon nutrition and health in general, especially in children.

Much space is devoted to the gross and microscopic appearance of tonsils with a classification based upon anatomic changes. Reference is made to the bacteriology of tonsils. The author believes that the indications for any form of treatment are more clinical than morphologic.

The method of irradiation employed consisted of 4, 6 or 8 treatments given at intervals of about a week through a small portal, 4 by 6 cm. In closing the discussion the author gives the physical factors used. Each tonsil was given a 5 minute exposure at each appointment, using 5 ma. and 150 to 160 kv., with 3 mm. Al filter. Best results were obtained with small doses at frequent intervals.

Treatments are particularly advised in 3

groups of cases: (1) chronic hyperplasia, whether simple or on a known infectious basis; (2) chronic interstitial tonsillitis, only rarely treated, and (3) chronic atrophic tonsillitis associated with chronic hypertrophic glossitis and pharyngitis. These are the pathologic conditions most amenable to irradiation.

Roentgen therapy should not be used in acute follicular tonsillitis, sepsis, generally not in acute leucemia even with tonsillar masses, mononucleosis, Vincent's angina, syphilis, diphtheria, scarlet fever or abscess of any type.

In those elderly individuals suffering from atrophic and hypertrophic arthritis, and conditions due to senility rather than infections in which tonsillectomy is of no avail, irradiation is likewise without benefit.

In general, roentgen therapy of the tonsils should not replace tonsillectomy in the rheumatic child, whether with or without endocarditis. It may be substituted with benefit in those patients who, because of some complications or because of the severity of their cardiac condition, are not proper subjects for operation. —*E. P. Pendergrass.*

SCAL, J. COLEMAN. The inoperable tonsil; treatment with radium in preference to other nonoperative methods. *Arch. Otolaryngol.*, April, 1930, *11*, 459–462.

The author gives his technique and reasons for his preference for radium in the treatment of the inoperable tonsil.

The technique consists in the implantation into each tonsil of two platinum radon seeds. Each seed contains 1.5 millicurie of radium emanation. The filter of the seeds is 0.33 mm. platinum, which practically eliminates 98.5 per cent of the caustic beta rays. The seeds are removed in from five to six days, as at the end of this time the maximal activity of the radon is spent. A silk thread is attached to one end of the seed for its removal. If the seed is not embedded deeply enough it will be dislodged and fall out as the result of the muscular action of the palate and pillors in swallowing. To prevent this the seed must be centrally placed in the tonsil and embedded so that the end of the seed is at least 2 mm. below the surface. By this method disease of the tonsil can be eliminated in from one to three months.

The advantages of radium treatment are that no anesthetic is required, hospitalization is unnecessary, and there is practically no disability.

The advantages of radium over roentgen therapy are that only one treatment is necessary, there is seldom any reaction and the lymphoid tissue of the tonsil is adequately affected without injuring any of the adjacent structures.—*E. P. Pendergrass.*

HAGER, BENJAMIN H. Direct irradiation of the kidney. *J. Am. M. Ass.*, Mar. 15, 1930, *94*, 762–764.

As the result of experience gained in the irradiation of neoplasms of the urinary tract, the author suggests direct irradiation of the kidney as a means of treating idiopathic hematuria which fails to respond to conservative measures. The author's records reveal 37 cases of essential hematuria. Of these, all but 3 responded to the customary instillations of solutions of silver nitrate, of variable concentrations, into the renal pelvis. One patient required nephrectomy because of persistent hematuria and a resultant secondary anemia. The other two patients were subjected to high voltage roentgen therapy.

The histories of these two cases are recorded. The roentgen therapy was given by Dr. Soiland and his associates. The following technic was used: 220 kv., 40 cm., filter, 1 mm. Al and 0.5 mm. Cu, 4 ma.; area 15 by 15 cm. field over the affected kidney; total time of 90 minutes anterior and 90 minutes posterior; 30 minutes every other day, a total of 6 treatments. Hematuria ceased in both cases and had not recurred in the first, two years and in the second, one and a half years after treatment.

Reference is made to the fact that nephritis has been produced by means of direct irradiation of the kidneys and that this might be a contraindication in the use of this method in essential hematuria. Dr. O. N. Meland, in the discussion, points out the fact that it is a question of dosage. In referring to the work of Hartmann and Doub who experimentally produced nephritis in animals, he recalled that they used enormous dosages—doses larger than are used in some malignant conditions. The cases of essential hematuria received a 37 per cent depth dose. While this dosage is purely empirical and evidently sufficient, it is, in addition, well within the limits of safety.—*E. P. Pendergrass.*

## MISCELLANEOUS

CALDWELL, G. H., and CRANE, A. W. Influence of phenolphthalein on intestinal movements. *Radiology*, Nov., 1929, *13*, 403–412.

From their roentgenologic studies these authors offer the following conclusions: Phenolphthalein in ordinary dosage has no appreciable effect on the movements of the stomach or the small intestine. Phenolphthalein does not directly affect the rate of movement, in any part of the digestive tract, of the food material taken simultaneously with it. The proximal half of the colon shows very little, if any, increase in its motor activity during the period in which phenolphthalein is most active, about eight to twelve hours after it is taken. The movements of the distal half of the large intestine are strongly stimulated by phenolphthalein during its active period. Phenolphthalein has no local effects in any portion of the alimentary canal due to chemical or mechanical action on the bowel wall. The drug is in part absorbed during its passage through the small intestine and reëxcreted into the colon or large bowel. The laxative properties of phenolphthalein are due chiefly if not entirely to a stimulation of the large bowel by that portion of the drug which is absorbed and carried by the blood to this portion of the tract. Only that portion of the intestinal contents which has reached the distal colon by the time the phenolphthalein becomes active, namely, about eight to twelve hours after its ingestion is directly influenced by it. Other apparent effects are secondary and indirect.—*J. D. Camp.*

Jacobsen, Victor C. Effects of high voltage cathode rays upon germinal epithelium of the rat. *Proc. Soc. Exper. Biol. & Med.*, Jan., 1930, *27*, 296–297.

A study was made of the effects of high voltage cathode rays on the spermiogenic epithelium of adult male white rats, about five months old, apparently healthy and virile. The shaved scrotal area was exposed in front of the anodal window of a Coolidge cathode-ray tube to a current of 1 ma. at 200 to 250 kv. All irradiation of more than 1 second duration was given in 1 second periods with about one-half second between each. The tissues were studied one to fifty days after exposure. The changes in the scrotal skin consisted chiefly of hyaline fusion of the collagen of the corium, acute necrosis of epidermal and hair follicle epithelium, with vascular changes occurring much later. Definite lesions were produced in the seminiferous tubules in a zone of about 0.6 mm. in depth in animals exposed for 20–30 seconds, with proportionately shallower penetration for the shorter exposures. Pycnosis, fragmentation and karyolysis of nuclei and depression of mitosis were seen in spermatogonia, spermatocytes, and spermatids, the Sertoli cells being least affected. The interstitial cells showed insignificant changes. The evidence was for much greater sensitivity of the germinal epithelium to this form of radiation. These observations, resembling as they do those made on roentgen irradiated testis are offered as further biological evidence that the effects of roentgen rays are not due primarily to roentgen rays but to the electron or cathode rays set free in the tissues.—*B. Cohen.*

Loeffler, Lothar. Röntgenschädigungen der mannlichen Keimzelle und Nachkommenschaft. (Roentgen injury of the male germ cell and the offspring.) *Strahlentherapie*, 1929, *34*, 735–766.

Experiments on plants and animals have shown that it is possible for roentgen rays to injure the offspring. This has not been proved so far for man. A questionnaire was sent to 110 men who are physicians or technicians working all the time with roentgen rays. No physical or mental injuries were seen in the children of these men that could be attributed with certainty or even with any great degree of probability to injury of the father's spermatozoa. The number of miscarriages in their wives was low as compared with the number, published previously, in women who had been irradiated. It amounted to 1 miscarriage to 11 normal deliveries. The number of children in the marriages of the men who had married after their roentgen work began was 1.5 children per marriage; if calculated only for the fertile marriages it was 2.1 children per marriage. Thirty-one per cent of these marriages (17 out of 55) were sterile. In 10 of these sterile marriages injury of the spermatozoa of the man could be demonstrated, or 18 per cent of the 55 cases. Among the whole of the 110 men questioned, without reference to age, duration of the roentgen work or time the marriage was contracted, changes in the spermatozoa could be demonstrated microscopically in 20 cases, or 18 per cent. In 7 cases after the injury of the spermatozoa had receded children were born. Six of these are recent cases; one had previously been published in the literature.

In one case normal children were produced in the stage of oligospermia.

Animal experiment has shown the necessity for great care in irradiating human reproductive cells; it is particularly important to protect roentgen workers against secondary radiation. In view of the possibility of mutations in the sex chromosomes, observations should be made on the sons of irradiated women and the sons of daughters of irradiated men. The frequency of abortion should also be observed in women who before marriage have worked as helpers in roentgen laboratories. And the children born of men while their spermatozoa were injured by roentgen rays should be followed up.

The question of the injury of human offspring by roentgen rays is by no means settled and the author is continuing work on it.—*Audrey G. Morgan.*

BELOT, J. Paravent protecteur du docteur J. Belot (G. Gaiffe, constructeur). (The protective screen of Dr. J. Belot (G. Gaiffe, constructor).) *Bull. et mém. Soc. de radiol. méd. de France*, March, 1930, *18*, 120–124.

Recently the author has constructed an apparatus for the "integral protection of the examining roentgenologist." The apparatus was intended for larger institutions or departments. In this article a simpler protective screen is described designed for smaller institutions and office work. The screen is made in the form of a cubicle, the posterior wall of the cubicle being left open. The patient steps on a platform and is pushed with the cubicle (which moves on castors) against the roentgenoscopic tube. The two lateral walls of the cubicle are protected with 5 mm. lead, while the anterior wall (on which the roentgenoscopic screen is mounted) is provided with 1 mm. lead (the roentgenoscopic screen having a protective value of 2 mm. lead).—*T. Leucutia.*

HERDNER, R. Les grands instantanés en radiographie, l'exactitude dans leur mesure, un compteur précis gradué en 1/100e de seconde. (Instantaneous exposures in roentgenography, the exactness of their measurement, an accurate timer graded in 1/100 second.) *J. de radiol. et d'électrol.*, Feb., 1930, *14*, 117–128.

The author constructed a very accurate timer for instantaneous exposures in roentgenography. The apparatus is based on the law of falling objects. A weight (bolide) provided with a lever having two arms at an obtuse angle, is dropped along a stand. One arm of the lever by hitting during its fall a roller mounted on a nearby stand (the roller being adjustable for any height) closes the circuit, while the other arm by hitting the ground opens it. All the operator has to do is to adjust the roller on the nearby stand to the height (calibrated in time units) necessary for the required time of exposure and push a button which automatically releases the weight and thus closes and opens the circuit.

A very simple method is used for the control of the accuracy of the timer. The top of a Potter-Bucky diaphragm is removed and a film (in black paper without intensifying screen) is placed on the bare lead grids. A special lead filter provided with a very narrow hair-like slit (parallel to the grids) is mounted on the lower end of the cone of the tube which is brought very close to the Potter-Bucky diaphragm. The Potter-Bucky diaphragm is set for maximum speed and the film (moving with the lead grids) is exposed for various lengths of time. From the number of lines appearing on the exposed film one can estimate the accuracy of the timer. If the current has 50 cycles per second, a phase (½ cycle) will correspond to 1/100 of a second, and the number of lines will express the time of exposure directly in phase units of the current. For this the author has chosen the arbitrary sign of Ω (reverse U in order to maintain the form presented by the sinusoidal curve of the phase of the current) which is equal to 1/100 of a second.

The unit is graded on the stand provided with the roller in such a manner that any exposure from 1/100 to 100/100 of a second may be obtained.

By making use of this very accurate timer the author was able to obtain excellent images of very thin objects (e.g., bones of a fish) with roentgen rays as penetrating as those used in deep therapy, indicating that soft roentgen rays (as claimed by some investigators) are not essential for the roentgenography of thin objects or those of low atomic weight.—*T. Leucutia.*

GALLY and BERNARD. Technique particulière pour la radiographie de profil de la colonne

cervicale. (Special technique for the roentgenography in profile of the cervical spine.) *Bull. et mém. Soc. de radiol. méd. de France*, Dec., 1929, *17*, 288–289.

The patient is seated with the head erect in straight lateral position. With the aid of the roentgenoscope the ray is centered to the midportion of the cervical spine. Then the film is placed in position, the cassette inclined towards the head, and roentgenograms are taken.

The advantage of the method is that on account of the dropping of the shoulders all the cervical vertebrae and the first dorsal vertebra are well visualized.—*T. Leucutia.*

Åkerlund, Å. Der "Spiralblendenkompressor", Spezialapparat für Detailbilder bei Kontrastuntersuchungen. (The spiral diaphragm compressor, a special apparatus for detail pictures in contrast examinations.) *Acta radiol.*, 1929, *10*, 421–426.

By means of the spiral diaphragm compressor it is possible to get special pictures, rich in detail and contrast, of small circumscribed areas of the body. It is designed more particularly for the closer study of surface elevations of the mucous membrane, and other minor changes in various parts of the digestive tract. It consists of a small rapidly revolving secondary diaphragm of Åkerlund's spiral system, which together with a motor and cylindrical case is put in an adjustable cylindrical tube; this tube is then focused on the object or area to be examined and any desired degree of compression exercised.

The spiral diaphragm compressor ensures simple and accurate adjustment of the picture under screen control; serial exposures with unchanged adjustment of the picture; varying degrees of compression under screen control; decreased distance between object and film, resulting in better definition of the picture; effective cutting off of secondary rays and freedom from crossbar shadows even on the shortest exposures.—*Audrey G. Morgan.*

Guggisberg, Hans. Der Einfluss der Röntgenstrahlen auf die Nachkommen. (The effect of roentgen rays on the offspring.) *Schweiz. med. Wchnschr.*, March 8, 1930, *60*, 213–219.

The literature dealing with the effect of roentgen rays on the offspring is analyzed by the author and grouped under injury to the fetus, to the germ plasm, and to the future generation (heredity of acquired properties). He concludes that the destructive effect of irradiation during pregnancy cannot be doubted; and at least in the animal experiments, injuries to the germ plasm were proved. The latter manifests itself in two ways, depending upon the dose. After small doses fertilization takes place but the ova die in the uterus. After heavy doses they lose the faculty of impregnation. As to the genetic factor, nothing is definitely known so far since the experiments of Little and Bagg, who reported hereditary malformations in the offspring of irradiated mice, could not be confirmed. From a clinical standpoint irradiation of the pelvis is most apt to lead to injuries of the generative organs; exposure of the remaining part of the body will in all probability not influence the ovaries; but even there caution is indicated in pregnant women. The same holds true for unnecessary and excessive diagnostic exposures during pregnancy. Strict indications for deep roentgen therapy to be applied over the pelvis are essential. If a pregnant uterus has been irradiated by mistake abortion seems advisable. No injuries should occur if women are irradiated during the climacteric. Temporary sterilization is completely condemned by the author. He is also opposed to the roentgen treatment of pelvic inflammatory disease before the climacteric, while the ovarian exposure with very small doses of roentgen rays for the purpose of regulating the menstrual function must be considered in each individual case.—*E. A. Pohle.*

Martius, Heinrich. Zur Frage der sogenannten temporären Kastration mit Röntgenstrahlen. (The question of the so-called temporary castration with roentgen rays.) *Klin. Wchnschr.*, Dec. 17, 1929, *8*, 2383–2386.

The author expresses the opinion that temporary castration as advocated by some investigators should not be attempted as a routine therapeutic procedure. Although there is no positive proof that children born following ovarian irradiation with small doses are injured in their development, such may occur in future generations. Therefore temporary roentgen menopause should be produced only in advanced age.—*T. Leucutia.*

Pankow, O. Keimschädigungen durch Röntgenstrahlen. (Germ injuries by roentgen rays.) *München. med Wchnschr.*, Feb. 21, 1930, *77*, 303–306.

After a discussion of the effect of roentgen rays on the germ cells and offspring, the author briefly describes the animal experiments which he has carried out in order to contribute to the elucidation of this rather complicated problem.

The experiments were done on rabbits, one ovary being irradiated through a lead cylinder which was introduced to the ovary through a laparotomy wound. The following technique was used: Wintz drum, Neo-Intensiv apparatus, 45 cm. focus ovary distance, 0.5 mm. Cu filter, 4 ma., 180 kv., 5 min. The animals were divided into four groups: (*a*) normal animals (10) not irradiated; (*b*) control animals (2) not irradiated but submitted to operative manipulation; (*c*) irradiated animals (2) with early fertilization, and (*d*) irradiated animals (11) with late fertilization.

Only one ovary being irradiated, in order to be able to compare the embryos originating from the two sides, a section of the uterus was performed just previous to term and the young of the two sides separated. They were then transferred to other rabbit mothers so as to give them the same amount and type of milk as in the controls.

It was found that the animals originating from the irradiated ovaries were less numerous and showed delayed development. The experiments will be continued so as to observe the effect of the germ injury on future generations. —*T. Leucutia.*

GUTZEIT. Die Erkrankungen durch Röntgenstrahlen und andere strahlende Energie. (The injuries produced by roentgen rays and other radiant energy.) *Klin. Wchnschr.*, March 8, 1930, *9*, 455–460.

After a brief consideration of the principles of the biologic effect of roentgen rays the author discusses the various injuries produced by the application of roentgen rays and radioactive substances such as general radiation sickness, local skin changes (early and late), the injury to the generative organs and to the blood, and finally the injuries resulting from both the mining and preparation of radium, mesothorium and other radioactive substances.—*T. Leucutia.*

ZACHERL, HANS. Das reticulo-endotheliale System beim Geschwulstkranken. (The reticulo-endothelial system in tumor patients.) *Klin. Wchnschr.*, Feb. 15, 1930, *9*, 289–292.

After a résumé of the literature dealing with the influence of the reticulo-endothelial system on the growth of tumors, the author arrives at the conclusion that there is a very close relation between the reticulo-endothelial system and tumor activity. Not only the processes of natural and artificial immunity but also the question of predisposition can be well explained on the basis of the effect of the reticulo-endothelial system.—*T. Leucutia.*

GOUIN, BIENVENUE, DAOULAS, and PÉRÈS. Transmission, par injection de sang, des caractères sanguins acquis par la radiothérapie sympathique. Identité des réactions acquises et transmises sauf chez le syphilitique. (Transmission through blood injection of the blood characters acquired by sympathetic roentgen therapy; identity of the acquired and transmitted reactions except in syphilitics.) *Bull. et mém. Soc. de radiol. méd. de France*, Dec., 1929, *17*, 286–288.

The injection of the blood of an irradiated healthy individual (in roentgen therapy of the sympathetic system) transmits to another healthy individual the blood characters produced by the irradiation, that is hyperleucocytosis, if the irradiation was administered over the spleen, and hypoleucocytosis or leucopenia if the irradiation was administered over the triangle of Scarpa, or over the axillae. Syphilitics in both instances respond with hyperleucocytosis, a peculiarity which permits, at least experimentally, a differentiation of a syphilitic from a non-syphilitic.—*T. Leucutia.*

WAGNER, AAGE. Investigations concerning the growth of some malignant tumors in roentgen irradiated tissue. *Acta radiol.*, 1929, *10*, 554–565.

Clinical observation has shown that while carcinomas of the skin are often easily influenced by roentgen rays, sarcomas are usually more resistant. This led the author to make a series of experiments to determine whether this difference is due to characters inherent in the tumors themselves or to the defenses of the skin being more readily mobilized against the one form of tumor than the other. As a means of determining this he irradiated a number of mice locally with equal doses of roentgen rays and afterwards inoculated groups of them intracutaneously with bits of either sarcoma or carcinoma, both equally virulent, and then compared the degree of proliferation in the two

groups of animals. From his experiments he concludes that the cancer-destroying forces of the organism are mobilized with equal readiness against carcinoma and sarcoma, provided the virulence of the two tumors is the same.—*Audrey G. Morgan.*

Böhm, Alexander. Blutbildveränderungen nach Buckybestrahlungen. (Blood formula changes following irradiation with Bucky rays.) *Strahlentherapie*, 1930, *35*, 592–596.

The author investigated the changes in the blood picture following irradiation with various doses of borderline rays and found (*a*) that a drop in the number of the total white blood cells occurs in every individual whether healthy or sick; (*b*) that the leucopenia is independent of the duration of the irradiation; (*c*) that there is neither sensitization nor desensitization; (*d*) that the qualitative blood formula shifts towards the left, and (*e*) that the decrease in the leucocytes is the result of an excitation of the parasympathicus.

It seems thus that the action of the Bucky rays is chiefly on the skin, the deep effect on the internal organs beng a reflectoric reaction of the autonomous nervous system.—*T. Leucutia.*

Wagner, Aage. Investigations concerning the influence of roentgen irradiation on the resistance to cancer in white mice. *Acta radiol.*, 1929, *10*, 539–553.

After describing the attempts that have previously been made to reduce resistance to cancer in white mice by means of general roentgen irradiation, the author describes his experiments in the use of a transplantable tumor that was only slightly virulent to determine the degree of decreased resistance resulting from irradiation. He shows these advantages by giving tables showing the increased percentage of takes of virulent and only slightly virulent cancer after irradiation.

The cause of the lowering of resistance to tumor by roentgen irradiation is not known. It is possible that the forces of the body which resist cancer are destroyed by irradiation. But at any rate the method of irradiation and transplantation of slightly virulent tumors can be used in studying biological questions in regard to cancer. The method can be used to keep alive tumors that are hard to transplant. It has been proved that certain tumors can be transplanted only to irradiated animals. It is highly probable that general irradiation may cause an artificially induced cancer to become manifest more readily. General irradiation may possibly favor the development of spontaneous tumors. —*Audrey G. Morgan.*

Reinhard, M. C., and Buchwald, K. W. No lead in tumor tissue after intravenous injection of colloidal lead. *J. Cancer Research*, Oct., 1929, *13*, 239–241.

The object of this research was to determine the amount of lead present in tumor tissue after the intravenous injection of colloidal lead. Mice, bearing spontaneous tumors, were selected for these experiments. The colloidal solutions of lead used were either the commercial lead diasporal or colloidal lead phosphate as prepared by the authors. In order to determine the amount of lead in the tumors two methods of analysis were used, chemical and spectral. These methods of analysis are briefly described.

Eighteen mice were used. The amounts of lead injected and the time of injection and death of the animals are tabulated. The results were entirely negative. Both the spectroscopic and chemical analysis failed to reveal any traces of lead in the tumor tissue. This is in accordance with the results of Martland and Sochocky—*Karl Kornblum.*

Thibaudeau, A. A., and Mattick, W. L. Histological findings in hearts which have been exposed to radiation in the course of treatment of adjacent organs. *J. Cancer Research*, Oct., 1929, *13*, 251–259.

The question as to the damage done to the heart when radiation therapy is given to lesions in close proximity to the heart is of considerable clinical importance. This paper deals with the histological study of hearts subjected to irradiation and the effect of such irradiation is compared with the findings in hearts not subjected to irradiation.

Three groups of cases were selected. The first comprised 10 hearts secured at autopsy from cases in which extensive irradiation had been applied in the precordial region, in the second group were 10 hearts secured from cases which had not been directly irradiated in the precordial area, while in the third group were 4 hearts from cases of malignancy in which there had been no radiation therapy.

The following changes were noted in the histological examination of the heart muscle:

necrosis, fatty degenerative changes, fibrosis, round cell infiltration, fragmentation of the muscle fibers, hyaline degeneration and brown atrophy. The degenerative changes noted in the three groups of cases are tabulated.

Short protocols of the 10 cases receiving direct cardiac irradiation are given. These indicated the type and quantity of radiation used. In some cases roentgen therapy, while in others, radium was employed.

From their studies the authors conclude that irradiation of the human heart may cause definite injury to the heart muscle. Degenerative changes were found to be more frequent and more extensive in hearts receiving irradiation than in those not irradiated. The degenerative changes in the irradiated hearts were also of a different nature than the changes found in the hearts not irradiated. Thus the muscle fibers presented a rather "woolly" appearance throughout, they were less healthy in appearance; cross striations of the fibers were less clear and distinct, staining was not as good in both the muscle protoplasm and in the nuclei; fibrosis was more frequent and peculiar in that it was more diffuse and in finer strands between the individual muscle fibers. In addition there was a greater amount of loose areolar tissue present and the tissues were much more edematous. The authors note that brown atrophy in their experience is a usual finding in the hearts of subjects dying from malignant neoplasms.—*Karl Kornblum.*

POITTEVIN, M. De l'importance du rayonnement secondaire en radiographie. (The importance of the secondary rays in roentgenography.) *Bull. et mém. Soc. de radiol. méd. de France*, Dec., 1929, *17*, 290–296.

Quantitative experiments show that the simple Potter-Bucky diaphragm is not sufficient to entirely eliminate the secondary rays during roentgenography. A Potter-Bucky diaphragm with double grids moving in opposite directions, however, will cut out all secondary radiation. From a practical standpoint this means that sharper roentgenograms are obtained and the time of exposure approaches more nearly the figures of the theoretic law.—*T. Leucutia.*

LA ROCHE, M. O. Nouvelle grille double oscillante pour radiographie et radioscopie. (New oscillating double grid for roentgenography and roentgenoscopy.) *Bull. et mém. Soc. de radiol. méd. de France*, Dec., 1929, *17*, 339–341.

A new Potter-Bucky diaphragm was constructed by using double overlapping grids which move (oscillate by means of a heart-shaped cam) in opposite directions.

The advantages of the apparatus are that the secondary radiation is seven times less than with any of the simple Potter-Bucky diaphragms now in use, that the central and concentric opacities such as produced with the rotating grids are eliminated, that both short (automatically interrupted) and long (electromotor driven) exposures are possible, that in longer exposures the motion is even and continuous, and that the dimensions of the apparatus are reduced to a minimum, yet permitting the use of 14″×17″ films.—*T. Leucutia.*

CHANTRAINE, H., and PROFITLICH, P. Ueber die Messung der Spannung bei ganz hohen Milliamperezahlen. (On the measurement of the voltage in very high milliamperage.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Jan., 1930, *41*, 44–48.

The measurement of the voltage for short exposures with very high milliamperage is exceedingly difficult. The sphere gap and the static high tension voltmeter (of Starke and Schroeder) are entirely unreliable.

The authors obtained the best results by the old method of Benoist and Wehnelt. The Benoist scale was read with the naked eye while the Wehnelt scale was photographed. A series of control readings (made by 9 different persons) for the Benoist scale and a check-up with the photographs of the Wehnelt scale revealed that within 35 to 50 kv. (maximum) the error committed amounted to only ±1 kv.—*T. Leucutia.*

SCHUBERT, MARTIN. Vergleichende Messungen mit Küstner-Eichstandgerät, Martius-Ionimeter and Sabouraud-Noiré-Tablette für die Dosierung in der Oberflächentherapie. (Comparative measurements with the Küstner standardizing apparatus, Martius ionimeter and Sabouraud-Noiré pastilles for the dosage in superficial therapy.) *Strahlentherapie*, 1930, *35*, 553–560.

The Sabouraud-Noiré radiometer and the sphere gap suffice for the practical measurements in superficial roentgen therapy. In applying the absolute unit, ionization chambers entirely independent of wave length must be

used. The Küstner apparatus is very reliable in this respect but the Martius ionimeter still shows some dependence on wave length, leading to erroneous measurements.—*T. Leucutia.*

Knipping, Paul. Ueber Physik und Technik der Kathodenstrahlen. (On the physics and technique of cathode rays.) *Strahlentherapie*, 1930, *35*, 391–402.

After a brief discussion of the nature and properties of the cathode rays, the author analyses their absorption and the mechanism of their effect.

With regard to absorption the cathode rays behave opposite to the roentgen rays, in that the fastest electrons are absorbed by the thinnest of filters. Heavier filtration leads to a complete annihilation of the fast electrons and only a few slow electrons are able to go through. For this reason the application of filters in cathode rays is not only unnecessary but directly contraindicated.

There are two theories for the explanation of the effect of the cathode rays: one is that the action is the direct result of the fast electrons and the other that it is indirectly through emission of slow secondary electrons. It appears that the detection of a chemical reaction which would permit the quantitative determination of some decomposition products at different depths depending on the penetration of the various electrons would lead to the final solution of the problem. Until then, we have to be content with hypothetical assumptions.—*T. Leucutia.*

den Hoed, D., and Stoel, G. Intensity measurements of radium rays. *Acta radiol.*, 1929, *10*, 442–461.

The photographic method of measuring the intensity of radium rays is very useful for quantitative measurements. Its advantages over the ionometric method are: (1) It is possible to measure the intensity very close to the source of the rays. With the ionometric method there are two difficulties in doing this; in the first place the ionometer is too large and in the second place it runs down too soon and the measurement is no longer accurate. (2) The measurement can be made over a very small surface, almost punctate. (3) The technique is very simple. (4) The roentgen films are documentary evidence.

Its disadvantages are: (1) There is difficulty in the use of complicated applicators. (2) The measurement takes too long a time when the intensity is determined at a greater distance. (3) The development, the measurement of the degree of blackening and the calculations require a great deal of time. When measurements are made by the photographic method it is of great importance to get blackening of sufficient intensity but that the value should not be greater than 1. The photographic and ionometric methods can be combined, using the former for small distances and the latter for greater ones. The measurements described above show that there are two methods of increasing the depth dose in proportion to the surface dose, first by enlarging the field of irradiation and second by increasing the distance between the skin and the applicator.—*Audrey G. Morgan.*

Thoraeus, R. Roentgen intensity and milliamperage from different constant-voltage machines. *Acta radiol.*, 1929, *10*, 515–532.

When an ordinary tube is kept working with a definite constant voltage, the intensity of the radiation emitted is found to be proportional to the milliamperage under the conditions used for therapeutic purposes at Radiumhemmett. The type and arrangement of the high tension generator do not have any effect. The essential point seems to be the use of condensers on the high tension side. Their capacity should be great enough to assure a constant voltage to within a few per cent with maximum output.—*Audrey G. Morgan.*

Spiethoff, B., and Berger, Heinz. Feldgrössenbestimmung bei der Grenzstrahlbehandlung. (Determination of the size of field in grenz-ray therapy.) *Strahlentherapie*, 1930, *35*, 90–97.

This is a detailed discussion of the size and nonhomogeneity of the treatment area of a Müller grenz-ray tube at various focal distances, and a presentation of a treatment plan of properly combined areas for the treatment of larger parts of the body.—*Otto Glasser.*

Schreus, H. Th. Der Stand der Strahlendosierung mit der Sabouraud-Noiré-Tablette. (Radiation dosage with the Sabouraud-Noiré tablet.) *Strahlentherapie*, 1930, *35*, 72–82.

The methods of measuring dosage in skin therapy have changed very little in the last

twenty years. The Sabouraud-Noiré tablets are still widely used. The sources of error in measuring doses with these tablets are again discussed in detail. Special attention is called to the fact that the radiation quality must be accurately determined when measuring intensities with the tablets; indication of voltage and filter alone is not sufficient. The author has determined the doses in r-units for various radiation qualities which produce identical reddening effects upon the human skin. He arrives at the following results:

500–600 r for 120 kv., no filter; 0.025 mm. Cu half-value layer
700 r for 120 kv., 0.5 mm.; Al 0.05 mm. Cu half-value layer
850 r for 120 kv., 3.0 mm.; Al 0.165 mm. Cu half-value layer

These results agree with the findings of other investigators. It is suggested to calibrate Sabouraud-Noiré tablets in r-units for given radiation qualities.—*Otto Glasser.*

BRAUN, R., and HOLTHUSEN, H. Einfluss der Quantengrösse auf die biologische Wirkung verschiedener Röntgenstrahlenqualitäten. (Influence of quanta upon the biological effect of various qualities of roentgen rays.) *Strahlentherapie*, 1929, *34*, 707–734.

After a detailed review of the work of Dessauer, Crowther, Zuppinger, Condon and Terrill, Glocker, Holweck and Lacassagne, on the relation between quanta and biological effect of roentgen rays, the authors describe in detail their experiments on ascaris eggs. The curves representing the effect of various doses of different qualities upon these eggs present the typical S-shape. A systematic relation between this shape and the average sensitivity of the test objects could not be found. Neither could an influence of radiation quality upon the shape of the curve be detected. The only factor which was responsible for a distortion in the curve was the time factor. Complete accumulation of divided doses was observed in anoxybiosis.—*Otto Glasser.*

SCHOLTZ, W., and DOERFFEL, J. Zur Frage der Dosierung und klinischen Verwendung der Buckystrahlen. (Problems of dosage and clinical application of Bucky rays.) *Strahlentherapie*, 1930, *35*, 83–89.

One of the structural difficulties of the present grenz-ray tube is the fact that only small areas can be treated. A number of applications are necessary because often a uniform distribution of the radiation is not easily obtained. The dose itself can be measured by a photographic method similar to that of Kienböck. A standard scale is made of exposures of a photographic paper for certain given times. The introduction of grenz rays has not brought about new methods or possibilities of treatment and cures, but many effects are produced more easily with grenz rays than with harder roentgen rays; grenz-ray treatments have the advantage of not producing serious sequelae or epilation.—*Otto Glasser.*

GLASSER, OTTO, and MAUTZ, F. R. Die Bedeutung der r-Einheit für die Messung der Dosis von Gammastrahlen des Radiums. (The significance of the r-unit for the determination of the dose of gamma rays of radium.) *Strahlentherapie*, 1929, *34*, 845–854.

Intensities of various combinations of radium preparations were determined in r-units with the condenser dosimeter and small ionization chambers (1/35 c.c.) for different filters, distances, etc. The results are collected in a number of curves and tables. The skin unit dose for gamma rays was determined as 2000 r. —*Otto Glasser.*

HABS, H., and KÜSTNER, H. Die Abhängigkeit der Luftionisation durch Röntgenstrahlen Alpha-, Beta- und Gammastrahlen vom atmosphärischen Luftdruck. (Dependence of air ionization by roentgen rays, alpha, beta, and gamma rays upon the atmospheric air pressure.) *Strahlentherapie*, 1929, *34*, 823–844.

This is a detailed discussion and a report of experiments to show the influence of temperature and atmospheric pressure upon radiation intensity measurements in various ionization chambers and upon the control measurements of dosimeters by different types of radioactive preparations. It was found that for the authors' "Eichstandgerät," the ionization by roentgen rays for all practical purposes is directly proportional to the density of the air. If this instrument is calibrated at sea level and then moved to high altitudes, the measured dose in r/min has to be increased by 6‰ for each 1000 m, (12‰ for the small "Eichstandgerät"). With the uranium standard of the Siemens dosimeter the ionization current produced is 5 per cent higher for each 1000 m. than it should be

according to the law of proportionality with density. For a small air wall chamber these values are from 3‰ to 6‰ and for an aluminum chamber up to 7.5 per cent. Fluctuations due to variations in air pressure in the same location can amount to 3–6‰ with the "Eichstandgerät," ±2.5 per cent with the uranium standard, ±1.5–3‰ with a small air wall chamber and ±4 per cent with a small aluminum chamber. The authors conclude that the errors when using small aluminum chambers are considerable and measurements with these chambers should be discarded. Without radioactive control an error of up to 11 per cent can be made in dosage measurements with large and small ionization chambers. The smallest influence of atmospheric conditions upon the measured dose was observed with the authors' "Eichstandgerät."—*Otto Glasser.*

Holfelder, Hans. Aktuelle Fragen der biologischen Dosierung in der Tiefentherapie. (Problems of biological dosage in deep therapy.) *Strahlentherapie*, 1929, *35*, 54–61.

A discussion of the historical development of the application of roentgen doses in deep therapy from the "Dosi refracta" with less penetrating rays, over massive doses with hard rays, saturated treatments according to Pfahler and Finzi, diluted doses according to Coutard to telecurietherapy. The author feels that the methods as developed by Pfahler, Finzi and Coutard offer a promising outlook for the treatment of deepseated cancer and probably can replace the expensive telecurietherapy treatments.—*Otto Glasser.*

Packard, Charles. The biological measurement of scattered radiation. *J. Cancer Research*, Dec., 1929, *13*, 373–382.

An experimental investigation of the measurement of scattered radiation by a biological method. A discussion is given as to the manner in which scattered radiation is produced. When a beam of roentgen rays enters a tissue, a part of its undergoes a change of direction and an increase in wave length. The amount of increase of the wave length depends on the size of the angle through which the primary ray is deflected. For a given angle it is always the same regardless of the nature of the scattering medium.

Attempts have been made by various investigators to measure the scattered radiation which escapes from the tissues in order to gain some idea of the amount of such radiation which is producing the biological changes in the tissue in addition to those brought about by the primary beam. Such measurements are usually made with a small ionization chamber connected with an electroscope, water being the scattering medium. The measurements of scattered radiation of a number of investigators are given. The results obtained are so divergent that there is no agreement as to the amount of scatter even under the same conditions of irradiation. There are various factors responsible for the difference in results reported; for instance, the construction of the ionization chamber is not yet standardized, also its position in respect to the scattering medium must be considered, nor can it be said that the scatter from a patient will be approximately the same as that from water. It has been shown that such radiation varies with the region of the body being irradiated. Jacobi and Liechti find the scatter from the thorax is 20.5 per cent, vertebral column 36 per cent and from the abdomen 28 per cent. The amount of scatter depends also on the wave length of the primary beam and on the area of the scattering medium. But even with the recognition of the influence of these various factors it is evident from results obtained that there are other sources of variation not yet controlled.

The author has determined the amount of scatter from a large area of solid paraffin by means of a Victoreen dosimeter and by Drosophila eggs. The biological method consists in exposing Drosophila eggs to beams of various voltages, both with and without scatter from the solid paraffin. The eggs are permitted to hatch and the percentage of hatching eggs is a measure of dosage. The proportion that lives after a definite dose, carefully measured by means of an open ionization chamber, is remarkably constant.

From the experimental work conducted the author found that the amounts of radiation scattered backward from paraffin by biological and physical methods agree rather closely, the latter giving slightly lower values. With increasing voltages, the scatter increases from 23 per cent at 60 kv. to 37 per cent at 190 kv.; at higher voltages it decreases somewhat.—*Karl Kornblum.*

L'INSTITUT DU CANCER DE LA FACULTÉ DE MÉDECINE DE PARIS. (The Cancer Institute of the Faculty of Medicine of Paris.) *Presse Méd.*, March 15, 1930, *38*, 381–384.

The new Cancer Institute of the University of Paris will comprise three services: the scientific service, the hospital service and the educational service. The scientific and educational departments are completed and their inauguration will take place shortly. The hospital service which will comprise 150 beds with all arrangements for the most up-to-date treatments (complete roentgen and radium therapy departments) is still under construction.

The article is illustrated with numerous photographs of this very modern institution.—*T. Leucutia.*

HERRMANN, HEINRICH, and JAEGER, ROBERT. Über eine Röntgenapparatur für ca. 400 kV Röhrenspannung. (On a roentgen apparatus for circa 400 kv tube tension.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, March, 1930, *41*, 426–430.

The authors were able to produce a high tension current of 400 kv. by making use of the Villard connection. The detailed construction of the apparatus is not described. The principle consists in leading one phase of each period of the high tension current (through a valve tube) to two condensers, while during the other phase the entire current is led to the tube, the voltage at the tube thus representing the summation of the voltage of the transformer and condensers.

An AEG therapy tube, type 3, was used. However, since this tube is built for a voltage of only 250 kv. it was found necessary to first work up the tube to the required higher voltage. This was done by gradually increasing the high tension voltage until the tube started to become unsteady. Then the voltage was slightly reduced and the tube run for $\frac{1}{4}$ to $\frac{1}{2}$ hour so as to drive out the gas. This procedure was repeated until a voltage of nearly 400 kv. was reached. The intensity of the current under these conditions was 0.5 ma.

It was found that the quality of the rays at 380 kv. and 3 mm. Cu corresponds to 4 mm. Cu half-value layer. This indicates that the roentgen rays are considerably more penetrating than those hitherto used. It is expected that with the construction of more powerful tubes, the use of the new apparatus will become general.—*T. Leucutia.*

NEEFF, TH. C. Toleranzdosen in der Röntgendiagnostik. (Tolerance doses in roentgen diagnosis.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, March, 1930, *41*, 414–426.

The author determined experimentally the maximum doses which could be tolerated by the patient during a roentgen examination. The following factors were taken into consideration: (1) the quality of the roentgen rays for various diagnostic irradiations (expressed in aluminum half-value layer); (2) the surface back-scattering, depending on the quality of the rays and the size of the field (expressed in percentage of the primary radiation); (3) distribution of the roentgen rays at various depths (expressed in percentage of the surface dose); (4) intensity of roentgen rays (expressed in r per minute in air); (5) skin tolerance doses under various diagnostic conditions, depending on the quality of the roentgen rays and on the size of the field (expressed in r per skin unit dose), and (6) the duration of the roentgenoscopy and the number of roentgenograms permitted without injury to the skin or deep structures.

Various curves and tables are given for the above factors. It is the author's opinion that the maximum doses used in roentgen diagnosis should not exceed 20 per cent S.U.D. for hard and medium rays, and 10 to 15 per cent for soft rays. In gynecologic examinations, if the ovaries are included within the field of irradiation, the dose should not exceed 5 per cent S.U.D.—*T. Leucutia.*

DIOCLÈS. Présentation d'une sellette-bouclier (Massiot, constructeur). (Presentation of a stool shield (Massiot, constructor).) *Bull. et mém. Soc. de radiol. méd. de France*, March, 1930, *18*, 96–98.

The author describes a protective shield provided with a stool, both being mounted on a tripod having castors. The advantage of the shield is that it can be easily moved to any part of the room.—*T. Leucutia.*

SGALITZER, MAX. Röntgenuntersuchung im Krankenzimmer mit hochspannungssicherer Apparatur. (Roentgen examination in the sickroom with high tension apparatus.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, April, 1930, *41*, 607–609.

The dangers connected with a roentgen examination at the bedside are: (1) electrical shock from the use of high tension wires in a sickroom, and (2) the insufficient protection of

the examining physician. Both of these are overcome in the Philips "Metalix" portable apparatus, which is highly recommended.—*T. Leucutia.*

Müller, K. W. Die Messung des Röhrenstromes bei Aufnahman. (The measurement of the tube current in roentgenography.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, April, 1930, *41*, 610–616.

The author describes in detail three methods for the measurement of the current during roentgenography: (1) the milliammeter method without adjustable indicator; (2) the milliammeter with adjustable indicator, and (3) the milliampere-second instrument. The advantages and limitations are discussed.—*T. Leucutia.*

Saidman, Jean. Les propriétés biologiques et thérapeutiques des rayons de 4–8 Angströms. (Biological and therapeutic properties of rays of 4 to 8 Å.) *Bull. et mém. Soc. de radiol. méd. de France*, Jan., 1930, *18*, 21–27.

The rays of 4 to 8 Å (emitted by a Dauvillier or Holweck tube) represent the longest roentgen rays used nowadays for therapeutic purposes. In investigating the biological and therapeutic action of these rays, the author found that they possess bactericidal power and that they produce an erythema which appears within twelve to seventy-two hours following the irradiation and which is of a progressive character. The skin presents a tolerance similar to that observed in ultraviolet rays, that is, even the largest doses fail to produce an ulceration. The pigmentation forms one of the principal biological effects of the rays, in some instances lasting as long as ten months.

Some therapeutic results were obtained in trichophytosis, eczema (the analgesic effect often appearing immediately following the treatment), varicose dermatitis, psoriasis and lupus. As a whole, the use of the rays does not present any advantage over the superficial roentgen therapy and actinotherapy.—*T. Leucutia.*

Behnken, Hermann. Dosimetrische Untersuchungen über Röntgenstrahlenschutz und Strahlenschutzröhren. (Dosimetric investigations on roentgen protection and self-protective tubes.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Feb., 1930, *41*, 245–256.

The quality of the roentgen rays emitted by various apparatus (Stabilivolt, Constantos, etc.) was determined (for different aluminum and copper filter thicknesses) in copper half-value layers and graphically recorded. Then the lead protective value for these various roentgen-ray qualities was analyzed and the results so obtained were also graphically plotted.

The self-protective value of two tubes (Media-Metalix and Metwa-Metalix type F) was determined by means of a specially constructed, very sensitive aluminum spherical ionization chamber. In connection with this the author measured (with the aid of a water phantom) the amount and distribution of the secondary radiation emitted by the patient. It was found that both tubes analyzed give a sufficient protection from the direct rays. As regards the secondary rays (emitted from the patient), it was found that if the patient is completely surrounded with a protective coating of 2 mm. lead equivalent except for the area which is treated and which must be exposed through a tight fitting lead diaphragm, the protection is likewise satisfactory. Under the above conditions the operator could stay at a distance of 50 cm. from the focus of the tube and in the immediate vicinity of the patient without there being danger of exposure.—*T. Leucutia.*

Schmitz, W., and Baumeister, R. Untersuchungen zur Lungenaufnahmetechnik mit Hochleistungsapparaturen. (Investigations on the technique of exposure of the lungs with high power apparatus.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Feb., 1930, *41*, 256–270.

The authors investigated the absorption of different thoracic tissues, for various hardnesses of roentgen rays, during the actual roentgen exposure of the chest. The photographic-photometric method was used for the reading of the roentgenograms. The exposures were carried out with intensities of 20, 40, 60, 80 and 100 sec. and with filters of 0, 0.6, 1.2, 1.8, and 2.4 mm. Al.

The absorption of the various thoracic structures was expressed in terms of water layers. It was found that the healthy lung (as measured in the intercostal spaces) of a normal strong patient has an absorption value of 6.5 to 7.2 cm. water thickness, while the value for the ribs is 7.5 to 8.5 cm. water. The absorption of the heart shadow could not be exactly determined on account of the fogging of the film. Morbid processes of the lung led to an absorption equiv-

alent to 8 to 10 cm. water thickness, while tumors gave an absorption as high as 12 cm. water.—*T. Leucutia.*

MÜLLER, K. W. Herabsetzung der Fehlergrenze bei Röntgenaufnahmen mit extrem kurzen Belichtungszeiten. (Reduction of the limits of error in roentgenography with extremely short exposures.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Feb., 1930, *41*, 270–275.

The author investigated the influence of various circuit breakers on the shortening of the time of exposure in roentgenography and found that two circuit breakers (one for the closing and one for the opening of the primary circuit of the high tension transformer) placed in series serve best the purpose. Graphic tables are included for the illustration of the precision of such an arrangement of the circuit breakers.—*T. Leucutia.*

PROFITLICH, P. Ueber Spannungsmessungen in der Diagnostik. (On tension measurements in diagnosis.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Feb., 1930, *41*, 276–279.

The author carried out a number of investigations in order to determine the accuracy of the sphere gap (12.5 cm. diameter) and of the Starke and Schroder high tension voltmeter in the measurement of the voltages in roentgenography. The results obtained were checked up by the Seemann spectrograms.

The measurements were made on valve rectified apparatus. It was found that if tubes with boiled water were used as serial resistances, the peak voltage value for the sphere gaps between 35 and 80 kv. was 2.5 to 5 kv. too high. On the other hand, if the Starke and Schroder high tension voltmeter was used for the measurement, the figures expressed the *effective* value of the voltage. Only after the adequate insertion of two valve tubes into the high tension line was it possible to read the voltage also in *peak* value.

Neither instrument was suitable for the measurement of the actual voltage in case of very short exposures. The author attempted to estimate the peak voltage indirectly by means of the Küstner apparatus from the loss of intensity due to certain filtration. The variation in the glass thickness of the tubes constituted here the only inconvenience; the error, however, was less than 1 kv.—*T. Leucutia.*

WINDHOLZ, FRANZ. Methodisches zur autoptischen Kontrolle von Röntgenbefunden, zugleich ein Beitrag zur Technik der Nekroradioskopie. (A method for the post-mortem control of roentgen findings, with a contribution to the technique of necroroentgenoscopy.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, March, 1930, *41*, 455–458.

The author advises that a lateral instead of the usual anterior incision be used for the opening of the body in post-mortem examinations. Such a procedure permits a more thorough inspection of the viscera and a better comparison of roentgen and necroroentgen findings.—*T. Leucutia.*

MÜLLER, K. W. Ein neues Nomogramm für Röntgenapparate. (A new nomogram for roentgen apparatus.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, March, 1930, *41*, 430–434.

A chart of technique is furnished with most roentgen apparatus for the expression of the interdependence of the primary voltage of the transformer and the voltage and intensity of the high tension current of the tube. While the values of the primary voltage of the transformer are plotted on the abscissa and the values of the high tension voltage at the tube on the ordinate of a coordinate system, the values of the intensity are charted in the form of parallel characteristic lines. The disadvantage of such a nomogram is that the values apply only to actual running conditions, whereas, as is known, every stepping up of the voltage leads to a proportional drop in the intensity of the tube current, a fact which cannot be calculated from the nomogram. In order to correct this error, the author constructed a new chart which permits the predetermination of the high voltage values if the milliamperage of the current of the tube and the primary voltage of the transformer (both of which can be read on the meters of the control board) are known. This is especially important in instantaneous roentgen exposures where the drop in the high tension voltage is often very considerable. The nomogram is reproduced and its use explained.—*T. Leucutia.*

SGALITZER, MAX. Zur diagnostischen Bedeutung von Fistelfüllungen. (The diagnostic significance of fistula fillings.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, May, 1930, *41*, 748–755.

The author emphasizes the importance of injection of fistulae with opaque media in cases of abscesses, biliary fistulae, etc. The proce-

dure not infrequently leads to detection of foreign bodies (gauze strips, rubber drains, etc.) and permits through the presence of a negative shadow the diagnosis of concrements (especially gallstones). Several roentgenograms are reproduced to illustrate the value of the method.—*T. Leucutia.*

Bouwers, A., and van der Tuuk, J. H. Strahlenschutz. (Radiation protection.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, May, 1930, *41*, 767–776.

The authors analyzed the maximum does which can be considered safe in the various practical applications of roentgen rays, and from the data collected from the literature they establish in a general way 0.2 r per day as the maximum tolerance dose.

In a number of experiments of their own the authors determined the number of r necessary for the blackening (0.5 index) of a double coated Agfa film (measured by a special photometer) for various types of radiations used in practical roentgenology. After making the necessary allowances and corrections (due to variation in the effect of the roentgen rays of different wave length on the fim), the following practical rules were established: (1) in routine diagnosis with medium hard rays (100 kv., 1 mm. Cu plus 1 mm. Al) a double coated film should show an exposure of 0.5 in a time not less than ten minutes; (2) in the diagnosis with harder roentgen rays (120 to 140 kv., 1 mm. lead plus 1 mm. Cu plus 1 mm. Al) a double coated film should show an exposure of 0.5 in a time not less than one-half hour; (3) in deep roentgen therapy (200 kv., 2 mm. lead plus 1 mm. Cu plus 1 mm. Al) a double coated film should show an exposure of 0.5 in a time not less than one day.—*T. Leucutia.*

Haret. Le protecteur intégral en fonctionnement (The functioning of the integral protector.) *Bull. et mém. Soc. de radiol. méd. de France*, May, 1930, *18*, 216–222.

The author describes in detail the arrangement, at the Lariboisière Hospital, of the integral protector of Belot and uses a schematic diagram of the layout of the department in order to demonstrate its working simplicity. The apparatus is wholeheartedly endorsed since it gives perfect protection to the examining roentgenologist. Its advantages and disadvantages—the latter being very few—are discussed.—*T. Leucutia.*

Lepennetier, F. Présentation d'un appareil destiné à projeter les films et tirages radiographiques sans réduction. (Presentation of an apparatus for projection of roentgen films and prints without reduction in size.) *Bull. et mém. Soc. de radiol. méd. de France*, May, 1930, *18*, 222–224.

The author described an apparatus constructed by Massiot for the projection of roentgen films and photographs in their actual size. A photograph of the apparatus is included.—*T. Leucutia.*

Guilbert. Stéréométrie par la méthode orthodiagraphique de Beyerlen. (Stereometry by means of the orthodiagraphic method of Beyerlen.) *Bull. et mém. Soc. de radiol. méd. de France*, May, 1930, *18*, 226–230.

The author presents the stereometric method of Beyerlen which, as is known, is based on the principle of the orthogonal projection of two cones intersecting at a point, (this permiting an accurate measurement of the distance), and describes its utilization in detail.—*T. Leucutia.*

Belot, J., and Lepennetier, F. La radiographie totale. (Total roentgenography.) *Bull. et mém. Soc. de radiol. méd. de France*, April, 1930, *18*, 201–205.

Denis Mulder of Java, in 1927, introduced the roentgenography of the entire body on one film, which he called "total X fotos." The method was further improved by Sicard and Gally.

The authors in studying this subject found the following technique valuable: 4 meter distance (the tube being either on the ceiling for horizontal examination or along the wall in vertical examination), 100,000 volts, 100 ma., Coolidge tube, duplitized film 2 meter long and 50 cm. wide placed in a specially constructed cassette, with intensifying screens. Special arrangement must be provided for the development of the film.

The method is of special value: (*a*) in localization of foreign bodies, especially in case of multiple bullets, in calcifications of the serous bursae, blood vessels, and muscle tendons; (*b*) in diseases of the osseous system, such as tuberculosis, syphilis, osteomas, osteomyelitis, neoplastic metastases, Paget's disease, osteomalacia, cystic osteitis, etc.; (*c*) in developmental deformities of the skeleton for the detection of asymmetries, atrophies, partial or total, arrest of development, delayed or accelerated union

of the epiphyses, etc.; (*d*) in postural anomalies of the skeleton, this phase of the work being especially important in orthopedic surgery; (*e*) in determination of the relation of various organs, as for example, the volume of the thoracic cage and the abdomen, etc.; (*f*) in applied anatomy in the arts. In this last, if the total roentgenography of the posing model is made with exposure for soft tissues, the contour of the various parts of the body and their relation to the skeleton can be visualized in a manner which must inspire the artist to greater precision.—*T. Leucutia.*

GUNSETT, A. Reactions cutanées mesurées en unités r électrostatiques. (Cutaneous reactions measured in r electrostatic units.) *J. de radiol. et d'électrol.*, May, 1930 *14*, 283–304.

This article deals extensively with the relation of the number of r to the erythema dose under various conditions (various filters, voltages, size of fields, etc.). The Dauvillier dosimeter was checked against the Küstner chamber and it was found that the number of r measured in Germany agreed very nicely with those of Dauvillier. It is advised, however, that when using the Dauvillier chamber for practical purposes, the measurements be carried out in air and not on the surface of the body, since scattered radiation affects to a large extent the Dauvillier chamber.

Measurements carried out directly on the patient with the use of the Hammer ionization chamber which, as is known, is independent of wave length, have shown that 1500 to 1670 r are necessary with 200 kv. and 2 mm. Cu to produce an erythema (the dose being given in fractions during a period of five days).—*T. Leucutia,*

CHIZZOLA, G. Sul significato delle immagini radiografiche consecutive a iniezioni endomuscolari di composti di bismuto. (The significance of roentgen pictures following intramuscular injection of bismuth compounds.) *Radiol. med.*, Feb., 1930, *17*, 150–158.

In a previous article the author described 2 cases of calcifying myositis. He found that the roentgen pictures of the muscles in these 2 cases were very much like those seen in the muscles of patients who have been given bismuth injections. The shadows commonly attributed to retention of bismuth in patients who have been given bismuth injections are seen chiefly after the intramuscular injection of insoluble bismuth salts in oil suspension but they have also been seen after soluble salts. The author believes that the pictures are not really caused by the retention of bismuth salts, or at least not exclusively so, but that they are caused by a process of parenchymatous or interstitial myositis which brings about degeneration of the muscle and deposition of calcium salts. The arguments he presents in favor of this theory are: (1) the fact that the extent of the roentgen shadows is not in proportion to the amount of bismuth injected; (2) the relative rarity of such pictures in syphilitics who have been given bismuth, indicating that in certain individuals there may be special local reactive processes; (3) the similarity in the pictures of so-called bismuth retention and calcifying myositis, and (4) the fact that it has been demonstrated that bismuth injections may cause a myositis. It has been definitely shown that bismuth salts have an irritant action on muscle tissue which results in an inflammatory reaction. The degree of the change varies in different individuals. Even some syphilogists admit that a sclerosing myositis follows bismuth injections.—*Audrey G. Morgan.*

DALL'ACQUA, V., AND ZOPPELLARI, T. Nuove ricerche sperimentali sull'azione biologica delle radiazioni nel snague circolante. (Experimental study of the biological action of rays on the circulating blood.) *Radiol. med.*, Jan., 1930, *17*, 57–67.

The authors irradiated the circulating blood through a thin glass tube bent into almost a complete circle and introduced into the carotid artery of a rabbit. For an anticoagulant they used novirudin manufactured by the Norgine Pharmaceutical Works in Prague; it does not cause any change in the blood cells. In both the irradiated animals and the controls there was an almost immediate increase in the number of cells after the operation but while in the controls the leucocytosis fell as if by crisis between the second and fourth days, in the irradiated animals the fall was not so rapid and continuous. There was no great difference in the animals irradiated with 2000 R and those irradiated with 3000 R. The authors think that the leucocytosis is a marrow reaction to products of decomposition of white cells changed or destroyed by the rays. From the blood formula it would seem that the lymphocytes are the least resistant of the cells to roentgen irradiation.—*Audrey G. Morgan.*

PRESTON M. HICKEY,
1865-1930

UNIV. OF

# Preston M. Hickey

## 1865-1930

DR. PRESTON M. HICKEY, one of the best known and best loved of American roentgenologists, died at the age of sixty-five in the full tide of work and at the height of his remarkable career. The history of his professional life is largely the history of the development of the roentgen ray with which his name is inseparably associated for all time.

Dr. Hickey was not ready to retire. He died at an age which, for men of science, may be most fruitful and most necessary for the preservation of the results of a life's work. He had led a life of unremitting activity. After achieving extraordinary distinction in private roentgen practice and as an investigator, writer and teacher, he accepted a new professorship which carried with it the formidable task of reorganizing and housing the roentgen-ray department of a great university. Finally with the work thoroughly systematized, with capable and devoted assistants, with exhaustless clinical material, and with the unlimited facilities of a great medical school at his command, he was prepared as never before for productive research, advanced teaching and the writing of books.

However, his accomplishments were of such value and his influence over his contemporaries so far-reaching that to any but his intimates his life seemed rounded to completeness. In those days when roentgenological methods were in the making, his management of apparatus and patients, his interpretation of screen and plate, and his literary sources of information were always open to the visiting roentgenologist. He showed what he had with the candor of a true scientist and explained it with the clearness of a born teacher. By lectures and demonstrations he was most of his life in almost daily contact with students who widely disseminated his ideas. Thus most that he discovered, devised, or adapted, passed currently into the practice of his contemporaries without effort on his part to publish or to claim priority. Nevertheless, the lengthy bibliography at the conclusion of this sketch is concrete testimony of the fact that he was one of the most prolific of roentgenological writers. But although he wrote much and covered a wide field yet we can see why his influence and reputation far transcended his published works.

Dr. Hickey belongs to Michigan. He was born in Ypsilanti, an educational center near Ann Arbor, in 1865. His father, a Methodist minister, moved to Detroit, then like an overgrown New England village, where young Hickey passed a happy boyhood and acquired his primary education. His character was formed in an atmosphere of culture and intellectual effort. It was inevitable that he attend college and his degree of A.B. was taken in

1888 at the University of Michigan where he was later to play an important part.

While Preston was still a boy his wise father, perceiving a scientific trend of mind, allowed him to fit up a little chemical laboratory in an upstairs room at home where he studied and experimented to his heart's content. Such early self-training has often a profound influence, and Hickey was then and there dedicated to the scientific life. It is no surprise therefore to find that he had entered the Detroit College of Medicine and Surgery from which he was graduated in 1892, three and a half years before Roentgen announced the discovery that was to influence Hickey's professional career.

During this interval he was practising medicine chiefly in association with Dr. E. L. Shurley who specialized in diseases of the nose, throat, and chest. He acquired a considerable reputation in oral surgery and invented a nasal snare that was widely adopted. He was proud of his success in tonsillectomy and became skilled in the use of the bronchoscope. An interesting mounted display of foreign bodies that he had removed by bronchoscopy is strongly reminiscent of the work of Chevalier Jackson. Later this work was to be one reason why a roentgen-ray machine should be added to his equipment. During this same period he was being drilled by daily practice in the examination of the chest. This proved to be another reason, still more compelling, for roentgen apparatus.

Dr. Hickey's recreation at this time was with a camera, in which respect we are reminded of Roentgen, whose hobby was outdoor photography. The lines of Dr. Hickey's life were converging. He developed photomicrography with enthusiasm and inventive ingenuity, and with it an expanding interest in pathology. Shortly we find him as a lecturer in pathology, a training invaluable for a future roentgenologist. He gained distinction by an original modification of the stereopticon whereby stained microscopic slides replaced photomicrographs for classroom demonstrations. But more important he developed himself as a teacher, and his old students have more than once told me of their affectionate admiration. His innate qualities of good nature, patience, tact, tolerance and friendly interest in the problems of others flourished in the atmosphere of the schoolroom.

Consider now the factors which led Dr. Hickey to his future work in roentgenology: a scientific type of mind developed by a general education, medical and surgical training, special work with the bronchoscope in the removal of foreign bodies, attention to the chest, that one cavity of the body readymade for roentgen examination, skill in photographic methods and dark room technique, and last but not least, a thorough knowledge of pathology, that ultimate foundation of roentgenological interpretation.

Some published work on the roentgen examination of the chest decided him, and in 1900 he began his x-ray work in the old Shurley Building which was to be a Mecca for roentgenologists. Nine years later he had become a

practising roentgenologist and the Professor of Roentgenology in the Detroit College of Medicine and Surgery which position he held until 1922. During this period he continued the private practice of roentgenology in association with Dr. William A. Evans, and was head of the Department of Roentgenology at Harper Hospital, which department he elevated to a high standing among roentgenological departments throughout the country. It was a favorite gathering place for physicians and surgeons for the discussion of cases and also for roentgenologists who sought new ideas in arrangement of rooms and equipment and the latest in roentgenological development.

Dr. Hickey made frequent trips to other laboratories and kept in personal touch with roentgenological advance everywhere in America and later also in Europe. When America entered the World War, Dr. Hickey was found in the Harper Hospital Unit which was one of the first to be sent abroad. In France he was promptly seized upon to assist in the general administration of the American x-ray forces. For considerable periods the whole weight of administration rested upon his capable shoulders. His even temper, tolerance and tact, became diplomacy. This important chapter of his life is best told by his comrades in France. His success is a matter of history. He entered the service as Major and was retired as Lieutenant Colonel.

On his return he resumed his old place and practice, with enhanced reputation, with a large European acquaintance, but with the same unassuming demeanor. His constantly enlarging practice made necessary the organization of a special therapy department and also the addition of a third member to the partnership, Dr. Lawrence Reynolds, who was persuaded to leave the Peter Bent Brigham Hospital. It is interesting that the editorship of the Journal which began in Detroit under the master hand of Dr. Hickey should have made the circuit of Battle Creek, New York and Washington, under some of the ablest men in the Society, finally to come back to Detroit under Dr. Reynolds.

When Dr. Hickey was appointed Professor of Roentgenology at the University of Michigan in 1922, he decided to visit the leading roentgenologists of Europe and study their methods and equipment firsthand. I accepted his invitation to accompany him with high anticipations that were more than realized. His foreign acquaintance was extensive because of his writings, his editorship and his war service. Nevertheless he provided himself with numerous letters of introduction which proved to be the "open sesame" wherever we wished to go.

This forethought was put to the test early in the trip. An emigration officer in Detroit directed us to obtain visas of our passports at Ottawa on our way to Halifax. But in Ottawa we were informed that we must return to Detroit for the visas. Our expostulation that we would miss our boat fell on deaf ears. The authorities were inflexible and indifferent. Hickey did

not share my utter discouragement but inquired the way to the U. S. Consul General for Canada who was stationed in Ottawa. Here, to my astonishment, he produced a letter from the Secretary of State at Washington directed to U. S. Consuls, asking that every consideration and courtesy be shown the bearer who was a distinguished citizen of the United States. This letter brought out the Consul General himself. He used the telephone a few moments and our difficulties vanished.

An incident on board ship revealed his background of culture. He was reproached by one of his fellow travelers for his absorption in the dry fields of science, and it was suggested that he should read the poets. "I have," said the Doctor; whereupon he recited with feeling the whole of Shelley's "The Skylark."

Dr. Hickey had also a strong artistic sense and loved to prowl in shops among pictures, rugs and antiques. Galleries possessed a fascination for him. We can understand why he was never satisfied with a roentgen plate unless it had a technical perfection and why his exhibits must not only show pathology but must also be faultless examples of artistic technique.

In Europe, particularly in England, Hickey was entertained as an outstanding representative of American Roentgenology. He was met everywhere with the utmost courtesy and consideration. Dr. Gordon Richards of Toronto, who joined us in England, represented Canada as Dr. Hickey did the United States. A special meeting of the London Roentgen Society was held in their honor. Dr. Hickey was a member of the American Delegation at the International Congress of Radiology in London, 1925, and in Stockholm in 1928. He was to have headed the American delegation at the Paris meeting of 1931.

At one time or another Dr. Hickey came in personal contact with most of the leading roentgenologists of Europe, especially of course in England, and the friendships formed were enduring and dear to him. He was one of the many connecting links which have brought American and European roentgenologists in closer contact perhaps than is the case with any other group of professional men.

When Dr. Hickey joined the American Roentgen Ray Society, its reputation was at a rather low ebb, but he saw its possibilities. It was due to his personal influence that Dr. Henry Hulst and myself became members in 1903. Many others could say the same. That he was the moving spirit in the making of the Society in its present form is shown by the affectionate term by which he was known to many members—"Pa Hickey." He interested himself in the publication of the Transactions. Finally, he decided that the time was ripe for a journal to replace the Transactions, and the first number of the *American Quarterly of Roentgenology* (which later became the *American Journal of Roentgenology*) was issued in October, 1906, with Hickey as editor. It was published in Detroit where Dr. Hickey saw to

every detail of printing, illustrating and distribution. It was for some years a laborious and thankless task which he put through with a persistence, ability and faith that were finally fully rewarded. He served as editor until when crowded by other work, he was succeeded as editor by Dr. James T. Case, in October, 1916.

Dr. Hickey's appointment to the University of Michigan Staff in 1922 was exactly timed by fate to allow him to plan a new department in a great new hospital. With that power of imagination so necessary in every constructive work, he visualized his department in full activity and fitted every detail into a general plan that provided for all kinds and conditions of x-ray work on a scale that the building committee thought impracticable. But Dr. Hickey prevailed. If he was visionary, it was the wisdom of one who knew. The perfect adaptation of this plan to the expanding needs of a large hospital may be appreciated by reading the description of this department in the 12th Series on Methods and Problems of Medical Education, Rockefeller Foundation, 1929. This department stands as a monument to his genius.

Dr. Hickey was seen to the best advantage perhaps in his various conferences with other members of the faculty and their staffs, always of course, with his own staff in attendance. These conferences were regular parts of the weekly schedule and dealt with issues and problems of actual cases. The assembled evidence of films and screen was to be correlated with clinical data, autopsy protocols, pathological and surgical findings, thus affording the widest scope for roentgen interpretation. Dr. Hickey, as a physician, diagnostician, a former lecturer on pathology and a master of roentgen technique could meet his most distinguished confrères on equal footing. Such a conference transported intact to the platform of a national roentgen-ray meeting, with members listening in, would form a feature of vital interest and value.

The beautiful Thomas Henry Simpson Memorial Institute for Medical Research owes its existence and location largely to Dr. Hickey who was the trusted adviser of Mrs. Simpson and chairman of the building committee.

Dr. Hickey never lost contact with the general medical profession. He was a member of the Detroit Academy of Medicine, of the County and State Medical Societies and of the American Medical Association. Before he lost his health he was prominently mentioned for the presidency of the American Medical Association. It was largely due to his influence that this Association formed a Section on Radiology. He was a past president of the American Roentgen Ray Society, a member of the Radiological Society of North America, the Detroit Roentgen-ray and Radium Society, and of the London Roentgen Society. He served two terms as a member of the National Research Council. In 1923, the Radiological Society of North America bestowed upon him a gold medal in recognition of his services to roentgenology.

Although he had little time for social activities, he was very fond of entertaining his friends in his beautiful home, as numerous roentgenologists can testify. In conversation the range of his interests and information was truly remarkable, enabling him to follow almost any companion with sympathetic understanding. He was also adept in the art of absorbing knowledge from acquaintances, a busy man's resource. He was a member of many clubs—the Athletic Club, the Yacht Club and the Aviation Club of Detroit and the University Club of Ann Arbor. He was always popular with his students and valued his membership in Phi Gamma Delta and Nu Sigma Nu.

The selection of Dr. Hickey to give the Caldwell Lecture at the Kansas City Meeting of the American Roentgen Ray Society in 1928 was one of the honors he most prized. His historical research in presenting the career of Eugene Caldwell led him into a general history of the first decade of Roentgenology in America which he finally published but which he was revising and enlarging at the time of his death. He was also collaborating with Dr. Skinner of Kansas City on the roentgen literature of this period.

In this historical survey he gives credit to all but himself. But we who know him know that Preston M. Hickey is forever identified with the development of roentgenology. He took up the roentgen ray when it was a scientific curiosity and laid it down as one of the foundations of modern medicine. He was active in the work till within a few days of his death, beginning in modest obscurity and ending in a position of unquestioned authority and world wide fame among his fellows.

A. W. Crane

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# PRESTON M. HICKEY

*His Relation to the University of Michigan*

In the untimely death of Preston M. Hickey, Professor of Roentgenology in the Medical School, the world of medical scientists has lost a distinguished contributor, the University a loyal alumnus and the Medical Faculty one of its most respected and eminent teachers. Born in Ypsilanti, it seemed quite natural that Doctor Hickey should have chosen Michigan as his alma mater. He entered the University in 1884 and was graduated with the degree of Bachelor of Arts in June, 1888.

His record as an undergraduate student and his choice of subjects for study gave no indication of the trend of his future career and of the high place he was to achieve in the field of science. They do indicate, however, the breadth of his learning and culture and constitute a commentary on the usefulness of a well-rounded classical background as a foundation for any career. It is interesting to note that besides botany and philosophy, Doctor Hickey's major courses were chosen from the languages. He is credited with twenty-three out of a total of ninety-seven hours in Greek and he also pursued, apparently with avidity, Latin, Sanskrit, French, Italian and German. Leaving the University in 1888, he pursued his medical studies at the Detroit College of Medicine and Surgery from which he was graduated in 1892.

He did not appear actively in University affairs until 1922. Up to 1913, the X-ray Department at the old University Hospital, while meeting the demands of the hospital as they existed in that day, was staffed for the most part by technicians and occupied a relatively unimportant part in the organization of the Medical School. The increased importance of the roentgen ray in the diagnosis and the treatment of disease led to the appointment in 1915 of the late Doctor James G. Van Zwaluwenberg under whose short tenure of office a real Department of Roentgenology was established under most difficult physical surroundings. The growth and development of this department was interrupted by the untimely death of Doctor Van Zwaluwenberg in January, 1922.

In casting about for a successor to Doctor Van Zwaluwenberg, the University authorities awoke to the agreeable surprise that one of its graduates had achieved one of the highest, if not the highest, place in the domain of roentgenology in this country. It was singularly fortunate for us that we were at this time able to persuade Doctor Hickey to assume the Professorship of Roentgenology, and it is a high tribute to his character that he was willing to forego the emoluments of private practice and devote himself on full-time to the development of a University department and to the further advancement of his professional career as an investigator, scientist and teacher.

During the eight years of his tenure of office, starting under the most difficult conditions, Doctor Hickey brought his department to the highest point of efficiency, established for it a reputation second to none in the country and in every way fully justified the University's choice and his own personal sacrifice in choosing a teaching career to round out his useful life. His ability as an organizer and administrator was immediately felt. His success as a teacher is not only attested by the high esteem in which the undergraduate medical student body held him but also by the fact that he almost immediately attracted graduate students from all over the world to his department. His quiet, modest demeanor established for him the high regard and respect of his colleagues; his intrinsic intellectual honesty in his diagnoses contributed to the high efficiency of the departments with which he was constantly working. Not the least of Doctor Hickey's contributions to the University's usefulness and influence was the prominent part which he played in the establishment at the University of the Thomas Henry Simpson Memorial Institute for Medical Research. His attention to his duties up to the very last, against the better interests of his health, is an evidence of his devotion to his science and his responsibilities.

The University of Michigan shares with the medical and scientific world the loss of an inspiring teacher, a distinguished scientist, and a devoted and loyal alumnus.

ALEXANDER G. RUTHVEN
*President, University of Michigan*

# PRESTON M. HICKEY

*His Relation to the Medical School, University of Michigan*

In September, 1888, I arrived in Ann Arbor to begin my medical course, and one of the first persons I met was Preston M. Hickey. There began then a friendship which lasted unbroken for over forty-two years, the memories of which are pleasant indeed. Dr. Hickey's cheerful optimism and his innate kindliness made of him always a most agreeable associate and friend. One of his most distinguishing characteristics was the broad charity which he exercized towards all human individuals. In all of the years of this association, I never heard him speak bitterly or harshly of any one, even of those who deserved criticism or blame. For these he had always a semi-apologetic smile or a humorous excuse. He met friends and patients always with the same good cheer; even during the last year when it must many times have been difficult for him to present a brave front to what he knew was facing him. But it was characteristic of the man to keep going until the last possible moment, and this he succeeded in doing until his final cardiac accident, only a few days before his death, which brought his activities forever to a close.

Dr. Hickey was prepared by heredity, his natural inclinations and tastes, and by his training for an academic life. He had always looked towards Michigan as a possibility; and when in 1922 he was elected by the Medical Faculty to a full-time Professorship of Roentgenology in the University of Michigan, he was genuinely pleased, and very happy over the culmination of his hopes and ambitions. He came to Ann Arbor proud of his position and eager for his new life. His previous training in the classics, and his later experiences in the teaching of pathology, with his years of practical experience in roentgenology fitted him peculiarly for the position on the University faculty. He knew how to meet students and patients; his classical training had developed in him a reasoning and analytical ability, while his scientific studies had taught him the necessity of minute and detailed observation, and the importance of conservatism in his diagnosis. Above all things he was open-minded, and always eager to learn and to profit through experiences. His mind was not primarily scientific; he was not preëminently an investigator. He had approached medicine by way of a training in the classics and this training had humanized him, made him thoroughly practical, and always desirous of playing safe. This reacted upon his scientific work; he preferred sailing along familiar shores rather than exploring the unknown. Hence his contributions bore a practical character and were not preëminently investigative.

He organized his department with great skill and success; indeed, it became one of the best organized departments in the University Hospital. He drew around him a loyal and efficient staff, and the amount of work

turned out during the eight years of his professorship was prodigious. It was always well and thoroughly done. He had mastered the technique of the various branches of his craft, and so could criticize intelligently and direct the work of the members of his staff. The result was a thoroughly well-organized combination that showed a very high degree of cooperation and technical efficiency. In the councils of the faculty, Dr. Hickey stood for progress and development. Although never aggressive, and usually inclined to take a middle course, he always threw the weight of his influence on the right side.

My chief association with Dr. Hickey during the eight years of his professorship was in the Friday afternoon clinical-pathological conferences. In these he showed an intense interest, and attended them as long as his strength permitted. His training in pathology gave him a special appreciation of the revelations of the autopsy and microscopic study of the cases presented in these conferences. He was always eager to correlate the pathologic findings with the roentgen diagnosis, and took great pains to explain discrepancies of interpretation. He came to Ann Arbor with certain fixed diagnostic ideas gained from practice and the literature of radiology, but was very quick to change these ideas on the strength of the pathologic findings. His appreciation of pathology and his conservatism of interpretation made him the safest reader of films that I have ever known. Because of this very cautious conservatism, his average of correct diagnoses and interpretations was remarkably high. He cooperated so well in these conferences, and took such a valuable part in them, that he will be sadly missed.

In the problems attending the instruction of medical students in methods of physical therapy, he took the greatest interest. He was thoroughly in sympathy with the aims and ideals of the Council on Physical Therapy of the American Medical Association. With his help a course of instruction in physical therapy was outlined, presented to the faculty, and accepted. An active department was created, composed of the faculty already engaged in teaching physical therapy subjects, and Dr. Hickey was appointed chairman of this department committee. In 1928 Dr. W. S. Peck was appointed Instructor in Physical Therapy and Assistant Director of the Department of Physical Therapy. In March, 1929, the Department of Physical Therapy was created by the Board of Regents; and in June, 1929, a course for technicians leading to a certificate in Physical Therapy was approved. The course in Physical Therapy for medical students, as outlined by Dr. Hickey and developed under his advice, was the most important pedagogical achievement of his teaching career at Michigan. It has since become a model for other institutions, and had the full approval of the Council on Physical Therapy.

To those of us who knew Dr. Hickey well, his loss is irreparable. No one who will follow him will present the same combination of personality and

character, or have the same attitude towards his work, or towards life in general. New ideas and new methods must necessarily follow, and a readjustment towards the new personalities must be made. It is inevitable that during this process the thoughts of his older colleagues will many times revert to Dr. Hickey with a keen sense of personal loss and deep regret.

A. S. Warthin

*Professor of Pathology, University of Michigan*

## HICKEY, THE TEACHER

In the lives of all of us there are some years which stand apart from the rest because of their unusual opportunities, achievements, or pleasurable associations. Such are the years I was privileged to spend under the training of Dr. Preston M. Hickey. Those who knew Dr. Hickey personally will understand, and therefore condone, the worship accorded him by his pupils.

We were attracted to his service at the University of Michigan Hospital chiefly by his reputation as a roentgenologist. By association with him we came to realize that this was but one of the reasons to consider ourselves fortunate in being permitted to study under his guidance. To properly record the interesting experiences of those years, to describe in detail his methods of acquiring and imparting scientific knowledge, to perpetuate the ideals and traits of his character, and to give an accurate account of the life and work of Hickey the Physician and Hickey the Man, would require the services of no less biographer than a Bosworth.

Consideration of the work of any really great teacher naturally divides itself into two parts: one relating to the special subject in which he was expected to give instruction and one relating to the more intangible things of cultural and social value. So in writing of Dr. Hickey, I shall deal with his ideals and methods of imparting knowledge in his chosen field, as well as with those no less important subjects he indirectly taught by reason of his character and personality.

Dr. Hickey possessed in large measure the requisites of a teacher, and especially a teacher of roentgenology. A student who read Greek for a pastime, an original thinker who conceived and promulgated many new ideas in his professional work, a social being who enjoyed wide contact with his fellows, a practitioner with many years of successful service to sufferers, a man of national, even international, prominence in the field of roentgenology before the University added the honor of its professorship—these and many other attributes qualified him eminently for the position.

His wide experience as a practitioner of general medicine, surgery and otolaryngology, and his training in pathology gave him an unusual background for his later work. As students under him we had not that lack of confidence in his clinical knowledge which is so evident in the case of certain men who have spent all of their lives in academic work. We were sure he knew what he was talking about and we were proud that he was able to uphold his side in arguments with clinicians and support his views with citations from his own experience.

He had a high opinion of his specialty. Roentgenology was, to him, the broadest of all the specialties, more than any other interrelated with every other. Being at a main crossroads, so to speak, the roentgenologist should

guide and direct the physician and his patient up the proper avenue for securing further light on diagnosis and assistance in treatment. This sense of the high calling of his profession led to frequent expressions of righteous indignation over the use of the term "x-ray man," which he considered as inapplicable to those of his group as "medicine man" or "knife man" would be to other groups of medical practitioners.

Dr. Hickey always maintained that the true function of a roentgenologist was that of a consultant, using his special knowledge, experience and equipment to aid the physician or surgeon in caring for his patient; as a consultant he must of necessity have an insight into, and up-to-date knowledge of, all of the specialties. Himself a tireless worker, he set an example of industry, and endeavored to inspire his students with a zeal for knowledge of medical subjects which would lead to constant study of the literature, that no advance or new discovery might be overlooked.

He frequently affirmed his belief that an interneship in internal medicine gave the broadest foundation and best fitted one for the practice of roentgenology. Not underrating any means of advancement of knowledge, he insisted upon attendance at all post-mortem examinations and, wherever possible, at the operation of surgical patients.

Dr. Hickey encouraged research and review of the literature not only in constant references to these matters in the course of routine work but he established frequent periodic conferences with round table discussions of current articles as well as historical facts. Not limiting this form of activity to members of his own department he was one of the chief sponsers of the Undergraduate Medical Society, a clearing house for research papers, and academic discussion among upperclass medical students, hospital internes, and young instructors.

Though a facile speaker and ready conversationalist, he was not an exponent of the formal lecture. He realized the impossibility of making a success of detailed teaching of a specialized subject to a large group of students. None knew better than he the soporific effect of a darkened room and a dimly visualized and more dimly appreciated film in the pit of the amphitheatre on the not too interested student in the back row. He believed any specialty should be taught to small groups in an intimate manner, and was constantly organizing students for elective courses in interpretation, technique and principles of roentgen therapy. The student was encouraged to visit the roentgen-ray laboratory at all times and to acquire his roentgenologic training in connection with his personal knowledge of the case. Democratic, he made the somewhat timid yet earnest junior feel that he was as welcome in the demonstration rooms as was the professor of surgery himself.

In addition to being one of the pioneers among professors of roentgenology in establishing courses in roentgenology for especially interested upperclassmen, he was instrumental in the inclusion of talks on roentgenology in

the curriculum of the freshmen, thus stimulating the interest of the young student in anatomy by relating it with later practical work and relieving somewhat the monotonous drudgery of unassociated memorizing. He also established cordial relations with the head of the Department of Physics, on whom he prevailed to provide courses in advanced roentgen-ray physics, giving his internes much needed knowledge of the theories of the action of roentgen rays and the principles of their production and application.

Within his own department, among his internes and residents, Dr. Hickey was likewise seldom given to lengthy didactic speech. He taught by precept to a certain degree, but the major part of his instruction was by observations of routine cases, casual or pointed remarks in words few in number but rich in significance. Knowing his long and varied experience and the accuracy of his observations, we were prone to give his utterances great weight. He, however, discouraged every tendency to the acceptance of authority as such, without original thought. On one occasion when a certain author was cited as an authority on a subject, he remarked, "He may have written a book but he hasn't seen any more chests than I have." We were invited to present our views and stand by them until convinced of error. His admonition to one of his men about to enter private practice was, "Be decisive; make up your mind about the case, give a positive opinion and stick to it." Those who knew Dr. Hickey well would not interpret this to mean that the opinion should be premature or ill considered. One of his outstanding characteristics was his policy of quiet reflection while others gave their ideas of the case under discussion. Then he would, in a very deliberate manner, confirm or dissent from the "snap" diagnosis with a well-founded opinion and reasons therefor. Never have I seen him allow himself to be hurried into making a positive diagnosis either from films of insufficient number or poor quality, or without proper knowledge of ascertainable facts.

While he developed to a high degree the study of films objectively, taking great interest in "Sherlock Holmes" deductions concerning age, sex, religion or any other characteristic of the patient which the film might reveal to his keen and experienced eye, he had little patience with the self-styled roentgenologist who habitually employed abstract film study for diagnosis. He was constantly striving to impress upon referring members of the hospital staff the necessity of including important data on their requisitions for roentgen studies.

Due to his instinctive humanity as well as his long contact with patients in private practice he never allowed the work of his department at the hospital to be conducted in such a manner as to overemphasize the laboratory or teaching side to the detriment of the interests of his patients. Our services were primarily for the benefit of the sufferer. We were instructed to be gentle in our palpation, careful in our manipulation of the affected part, and to avoid undue delay when the patient was waiting in discomfort. He set for

us a fine example of gentlemanly kindness and fatherly solicitude toward young and old, rich and poor alike. For these qualities he is remembered in gratitude by thousands who have consulted him.

In the training of his internes, Dr. Hickey insisted that they obtain a history and make sufficient physical examination of the patient to assure a proper roentgen study. This he considered the duty of the roentgenologist himself, and not to be left to a clerk or technician who could not, by reason of limited education, be qualified to exercise the same medical judgment as a physician. The value of a good technical assistant, especially in private practice, was not underrated, but he held to the ideal that the roentgenologist should direct and supervise every case if not actually make the films.

A firm believer in the elevation of roentgenology above a mechanical plane, and of the roentgenologist above the status of a technician who received detailed instructions from supervising surgeon or internist, he nevertheless held that the good roentgenologist should know more about the technique of making roentgen examinations than his technician in order to properly instruct him and correct his errors. To this end, the first requirement with which the entering interne was met was that of thoroughly mastering technique. Days, weeks, months, were spent in the exposure and developing rooms, and in the writer's day this included many weary months with the dental and portable machines. The lay technician in the exposure room was replaced by doctors who had full charge and were responsible for the quality of the films and the kind of exposures made. Frequent were the "calls upon the carpet" for careless work, such as inexcusable artefacts or under or over exposures. The interne was required to keep a notebook with the data of all exposures in relation to the thickness of the patient and the development of the films, as well as to check each morning the results of the work of the preceding day. This rigid and at times rather onerous training continued even after one had reached the rank of instructor, the intra-departmental rotations still including the exposure room service. Far too many roentgenologists are today relying on technical assistants to do their work, indeed some of them see personally a relatively small number of the patients whose films they diagnose. If Dr. Hickey could feel that his influence had in some measure tended to lessen this prostitution of the proper practice of roentgenology he would feel that he had not lived in vain.

The interne was taught self-reliance, for he alone was held responsible for the satisfactory study of his patient. For example, during his months of service in the chest room he was required to take a brief history, examine the chest roentgenoscopically, make the films and interpret them, dictating and signing a formal report which became a part of the hospital record. The delegation of such responsibility to an interne or resident has been criticized as failing to safeguard the interests of the patient. However, discussion of cases between members of the staff was encouraged and the Chief was at hand

whenever possible, ready to be consulted and expecting to be consulted upon all important or unusual cases. Furthermore, in an institution such as the University of Michigan Hospital, findings are so thoroughly checked and re-checked that the chances for error due to this source are slight and Dr. Hickey discounted them.

Except in the days of his early incumbency when the roentgen-ray department was in process of re-organization and removal to the new hospital, his staff members never lacked for good apparatus with which to work. How much of it he himself designed will never be known, for the innate modesty of the man was such that his own intimates had little idea of the large number of mechanical devices or special methods of examination which were fathered by him and should bear the Hickey name.

Always experimenting in an effort to find new and better procedures, he encouraged his pupils to experiment. His answer to every new theory or method was not one of cynical criticism, but rather, "Let's try it out and see how it works." A true pioneer, he was on the alert for new developments. His wide acquaintance and contacts were of great value to us, as he discussed the latest achievements with the leaders of the field long before the profession at large was cognizant of them and we were therefore in the vanguard of the science.

By nature an enthusiast, Dr. Hickey was liberal in his praise of creditable performance and equally liberal of criticism of careless work. His criticism was, however, never personal, and he never allowed his emotions to betray him into unkind remarks about others. His policy was to keep a discreet silence in any case in which he could not commend. Giving his fellow men credit for good intentions, it seemed at times that he was too prone to be deceived by the machinations of the politician or the hypocritical flattery of the self-seeker. Perhaps he was; it is a generous fault. But we sometimes wonder if this apparent over-confidence in the sincerity of his associates was not more the result of his faculty of seeing the good in the man than of inability to detect the evil.

When I first entered his service, Dr. Hickey's department was located in the basement of the old hospital. The equipment was poor and the personnel limited in number. It seems, in retrospect, that the finest part of our training was obtained under these conditions. The association was intimate, informal and uninterrupted. As the work increased, the staff was enlarged by several hundred per cent and we moved to the commodious quarters in the new hospital. Necessarily many changes were made in the conduct of both the clinical and teaching phases. The demands on Dr. Hickey's time became very great. His remarkable capacity for organization, for attention to details, for pouring oil on troubled waters through a diplomacy that was always aboveboard, made his services increasingly sought after for administrative work in the affairs of the Medical School and other organiza-

tions. We were jealous of his time for there was a sense of security in his solid presence which smoothed so many difficulties from our path. He did not neglect his x-ray work, but the extra activities necessitated more evening hours at the hospital and no doubt hastened his untimely death.

A great privilege it was to gather after hours to learn the practical points of roentgen diagnosis, uninterrupted by visiting physicians. Pressing indeed was the engagement which would cause an interne to miss one of these fruitful evening sessions. The routine films would be diagnosed for a while and then with a chuckle and a twinkle in his eyes, the Chief would tilt back his chair and say, "That reminds me—." Anything might follow: a story of the war; a reminiscence of early days as a young practitioner; a bit of science gleaned from a popular journal; a remark about his favorite hobby, pictorial photography; but whatever it was, it was full of interest and flavored with his clean, wholesome humor. Truly an association with him was a liberal education.

Dr. Hickey had the happy faculty of preserving the respect of his subordinates without inspiring fear. He encouraged esprit de corps and camaraderie among his assistants. Long to be remembered by anyone who had service in the old basement laboratory are those social functions which brightened many an afternoon. No birthday was allowed to pass uncelebrated and no member of the staff allowed to depart for new fields without a suitable farewell party given in his honor. The Chief was in his glory when cutting the cake or serving the ice cream, and he proudly introduced as his guest any visitor who might be in the department at the time. All work was reduced to a bare necessity and the affair was enjoyed by everyone from Dr. Hickey to the humblest orderly. The few minutes of relaxation relieved tired nerves and sent us back to work with the feeling that life was not such an unpleasant proposition after all.

To us who knew him best he was far more than a physician or professor of roentgenology. He was a sort of second father to his men. To him we could take our problems, were they medical or otherwise, and be certain of a sympathetic ear. His oft-proved wisdom, his sense of propriety and justice, gave us supreme confidence in his judgment. His kindly manner and fatherly interest in our affairs made us trust him implicitly. Were we impetuous, his quiet manner curbed the hasty speech or action; moody, his jovialty cheered and refreshed; tired or ill, his sympathy was as a healing balm; discouraged, his unswerving optimism urged to success; inclined to laxity in performance of duty, his own untiring industry spurred to greater effort.

Dr. Hickey taught the science of roentgenology and he also taught the art of dealing with patients, the art of living with one's fellow men and the art of developing in one's self the inner man with its highest cultural and spiritual attainments.

Is it any wonder that his pupils remained his true friends and admirers

through life, remembering him in gratitude and appreciating him more as age and experience taught them more of the higher aspects of living of which he was so much the master?

E. Walter Hall
*Former Instructor in Roentgenology, University of Michigan*

## HICKEY AND THE AMERICAN ROENTGEN RAY SOCIETY

To no man is the American Roentgen Ray Society more indebted than to Preston M. Hickey. In the early days of the Society Hickey's was the dominant influence that shaped its course and helped so greatly in establishing our specialty.

To his keen judgment of men we owe much in the selection of those splendid men who constituted the personnel of our organization. As president he further impressed upon it that calm dignity, conservatism and fairness which were his inherent qualities. By his great work as founder and editor of our first official organ he laid the foundation for our present splendid Journal. His kindly word of praise was ever a stimulus to scientific progress; his timely word of warning ever a curb to dangerous and extravagant over-enthusiasm.

The ideals of the American Roentgen Ray Society are but a reflection of Hickey's: steadfastness of purpose, unceasing search for truth, untiring effort in the alleviation of human suffering, these were his and these are the principles of this Society.

Inspired as we have been by his living presence it must be our aim to follow the course that his hand has charted and may the spirit of Hickey lead the way.

A. B. Moore

*President, American Roentgen Ray Society*

### Hickey's Work with the American Medical Association

Everyone who knew Dr. P. M. Hickey and who worked with him appreciated his judgment, his enthusiasm, and his kindness. He secured cooperation by maintaining a cordial and friendly attitude under the most trying circumstances. Regardless of the immense amount of work which he regularly carried, he did not at any time decline a request to assist any effort on the part of the American Medical Association in furthering the work of its various councils, its sections, or its other activities.

Morris Fishbein

*Editor, Journal American Medical Association*

Dr. Hickey was always interested in the scientific endeavors of the American Medical Association. His death removes one whose cooperation, work, and mature judgment made him an outstanding Fellow. His willingness to cooperate was with that spirit of modesty so inseparable from the character of him; his was not the desire to be acclaimed or to seek honor for the sake of honor. Dr. Hickey ever had in mind the scientific advancement of medicine, and particularly the field of radiology to which he was such an eminent contributor.

During the last six years it was my good fortune, as director of the Scientific Exhibit, to have had the cooperation of Dr. Hickey in raising the standards of the radiologic exhibit at the annual sessions of the American Medical Association; and thereby increasing both the standard and prestige of American radiology. In these yearly undertakings Dr. Hickey lent of his knowledge and his labors unstintingly. No matter was too small for him to consider if it came within his purview as chairman of the committee on the section exhibit of radiology. To me this attribute is always one of greatness in men who have great demands made on their time. His advice to the members of the Committee on Scientific Exhibit, particularly Dr. D. Chester Brown, Dr. Rock Sleyster, and Dr. J. H. J. Upham, was that of one who had an unusually wide perspective. Indeed in more instances than one was his profound knowledge of pathology, of general medicine, of radiology, and of physical therapy of real service to the national organization.

The loss of Dr. Hickey is a loss to all that's best in the medical profession; it is also a grievous personal loss to those who had opportunity to commune with him as a man of science and of high purposes.

Paul Nicholas Leech
*Director, Scientific Exhibit, American Medical Association*

## A Note on the Military Career of Preston M. Hickey

The military career of Preston M. Hickey was characterized, as was the work of his entire life, by hard work, modest self-effacement, and a faithful performance of every duty assigned to him, however uninteresting and distasteful it might seem. One of his outstanding characteristics during his entire army career was his unusual ability to cooperate and maintain cordial relations with his colleagues both of the regular army and those from civil life. It would be possible to detail many instances where such cooperation resulted in increased efficiency and in expediting the work for which he was responsible. We emphasize this quality because the physician is notoriously an individualist and usually finds it difficult to adapt himself to situations in which cooperation is necessary to secure the best results. Dr. Hickey had

this quality in an unusual degree. He maintained the most cordial relations with medical officers of the regular army upon whom fell to a large extent the medical administrative work of the war. This quality was also exemplified in his relations with medical officers of all ages; to the young he was a teacher, counsellor, and trusted friend; to men of his own age he was a valued consultant and one whose sane judgment could always be relied upon. He was held in high esteem not only by the medical personnel of our own army but by many medical officers of the French and British forces. Even under the stress of war conditions he constantly exhibited that kindly charity towards everyone which was perhaps his most outstanding characteristic.

Dr. Hickey went to France with the American Expeditionary Forces early in 1917 as roentgenologist with the Harper Hospital Unit. He was early detached from that duty and assigned to the larger duty of consultant in roentgenology. In this capacity he served until the end of the war, giving invaluable service as a teacher to the younger roentgenologists in the base areas throughout France and as an adviser to those charged with administration of the x-ray work in the entire A. E. F. He was commissioned as Major when he entered the service and at the end of the war he returned to civil life with the rank of Lieutenant Colonel.

His army experience was only a short, although important, incident in the long medical career of Dr. Hickey. It was characteristic of him that he entered upon it with careful consideration and that he fulfilled its exacting duties with the same faithful thoroughness that characterized all of his work throughout his lifetime. It was typical of the man that although he was long past the age when military duty could have been required his ideals were so high and his patriotism of such a quality that he was one of the first to offer his services to his country.

ARTHUR C. CHRISTIE

## HICKEY, THE SCIENTIST

He was a faithful servant of mankind, an earnest seeker for truth, an able practitioner, an inspiring teacher, a wise counsellor, the perfect friend.

It would be hard indeed for any man to find among all his acquaintances a life more worthy of emulation than that of Dr. Hickey.

In a book of poems by Edgar A. Guest, which Dr. Hickey sent me, this simple and modest one reminds me strongly of him:

I'd like to think when life is done
That I had filled a needed post,
That here and there I'd paid my fare
With more than idle talk and boast;
That I had taken gifts divine,
The breath of life and manhood fine,

And tried to use them now and then
In service for my fellow men.

I'd hate to think when life is through
That I had lived my round of years
A useless kind, that leave behind
No record in this vale of tears;
That I had wasted all my days
By treading only selfish ways,
And that this world would be the same
If it had never known my name.

I'd like to think that here and there,
When I am gone, there shall remain
A happier spot that might have not
Existed had I toiled for gain;
That some one's cheery voice and smile
Shall prove that I had been worth while;
That I had paid with something fine
My debt to God for life divine.

He had all of the attributes of a great scientist—an absorbing interest in his physical environment; an active, keen, analytical mind; seemingly limitless patience; ripened judgment; a keen sense of proportion; the generous desire to share his knowledge with others, and a deep sense of personal responsibility urging him to use his great talents either directly or through his coworkers for the attainment of useful ends. And with it all, there was a quiet and never failing sense of humor which made possible a very unusual amount of cooperation with his fellow men.

Great as were his contributions to the science and art of medicine, however, we are forced to admire him still more as a man. We can never forget his tolerance and charitableness, his kindly face and manner, his gentleness and his generosity—he gave credit where credit was due and always with fine, intelligent discrimination.

His good work will go on, and the world will always be a better place for his having lived in it.

W. D. Coolidge

## Preston M. Hickey

*An Appreciation*

The name of Dr. Preston M. Hickey stands out among those scientists who have contributed greatly to the advance of medicine by utilizing the visual sense through roentgenology. Dr. Hickey combined the rare qualities

of the man of research, the teacher, and above all, the clinical investigator. In the death of Dr. Hickey American medicine has lost an outstanding member, a scientist and a humanitarian, but the work which he loved will go on. The world is a better place because he lived.

W. J. Mayo

Although I had previously known of Dr. Hickey and of his skill in the practice and teaching of roentgenology, it was not until 1915, when I was a novice in the art and just beginning to practise it in Muncie, Indiana, that I first made his acquaintance. In that year I met him in Chicago at a meeting of the American Roentgen Ray Society, and I was greatly flattered by his extreme courtesy, democracy, and fatherly interest in my welfare. After that, whenever I saw him, he always had time to chat, inquire as to my progress, give me something from his store of wisdom and inspire me to renewed effort.

I was only one of many recipients of his favor, for he was a genial man, friendly to all the world, and his outstanding trait was a keen and kindly interest in the younger men of his profession. The nickname "Pop" Hickey was not an idle jest but a fond designation by his pupils and all beneficiaries of his paternal regard. I saw him in 1922, shortly after he had been offered the post at Ann Arbor, and he was elated, partly because he could now carry on his work in the way he wished, but especially because he would have a wider opportunity of training young men. Not long ago he contributed to this Journal a series of entertaining sketches dealing with the early history of roentgenology in America. Now he has gone to join the past of which he wrote.

Fair, tolerant, even generous, in his judgment of others, he nevertheless adhered firmly to the right, and his integrity as man and physician was never open to doubt, for he was indeed "a rock in a weary land." Although essentially conservative, he was, as Dr. Hugh Cabot has remarked, quite free from the intellectual stiffening seen so often in the later years of life, and to the end he preserved an extraordinary receptiveness and freshness of mind.

His serenity, good humor, impartial judgment and wise counsel brought solace to trouble and peace to strife. As a physician he was a doctor of the old school, like Weelum McClure, for the welfare of his patients was his supreme thought, to the utter neglect of his own financial needs. Many men are considered great by those who know them least; Hickey seemed greatest to those who knew him best.

In his zeal to serve others he gave no heed to the call of Fame. The high places he held—one time president of the American Roentgen Ray Society, chairman of the Radiologic Committee of the 1932 Chicago Exposition, Professor of Roentgenology and, at one time, Acting Dean of the School of

Medicine at the University of Michigan—were honors well earned, but he regarded them rather as duties. All that he gave to roentgenologic science will be mingled n the common heritage of future roentgenologists who will scarcely recall the name of the giver. But the impress of his fine character on the men whom he trained, the kindliness that he showered on all whom he knew and the gratitude of his patients will be passed on as a leaven without end. No man could have a more enduring monument than this.

B. R. Kirklin
*The Mayo Clinic*

My dear Kirklin:*

. . . . . .

"Now we are on our way to see dear old Pop Hickey to whom we, across the water, look as the father, the wise father, whose counsel is always free from pettiness and whose views will be broad and absolutely honest. It is always worth waiting to see what "Pop" thinks. Some few years ago my choice lay between carrying on an increasingly strenuous practice or taking up academic work at a ridiculous salary and his judgment was a large factor in my decision. How nicely he balanced all the arguments pro and con and yet did not in any way force his advice. It is sad to think of him as a sick man, one from whom we must withhold those difficulties that we know he would love to help us to solve. It was in the early days of the war that we first met and on several occasions it has been my privilege to have him as my guest and no more welcome guest have I ever entertained. I think of him up in the early dawn wandering around the garden at Windermere, drinking in the wonderful beauty of the scene and with that humorous smile of his, playing ball with the dog. And then, another picture, at Niagara, when he and many others came back from an excursion to the Hydro Electric works, black as tar from the smoke of an engine. Then he raised his blackened straw hat and the white patch above the black face was irresistable to me, and to him also when he caught sight of himself in the glass. I do hope that we may find him better, but the accounts we have are not encouraging."

. . . . . .

A. E. Barclay

Preston M. Hickey—Caldwell Lecturer, 1928

For the 1928 meeting of the American Roentgen Ray Society, Dr. Hickey was chosen to give the annual Caldwell Lecture. At the annual banquet on

* An excerpt from a letter written to Dr. B. R. Kirklin of the Mayo Clinic by Dr. A E. Barclay of England on his visit to America in September, 1930.

the succeeding evening he was presented with a silver service as a sincere expression of the affection of the members of the Society.

Dr. Percy Brown was chosen to make the presentation, which he did with the following remarks:*

There are some individuals who, when the Fates ordain that their turn has come for public utterance, cannot overcome an anticipatory feeling of dread lest some error of omission or of commission be made that would not occur were the words to fall from lips more worthy. The speaker is one of these, and his realization of his limitations is just now the more acute because he can so easily err by attempting to refresh, with the poor varnish of weak words, a mental picture of yours whereof the rich and stable pigments need no refreshing.

Of his audience of last evening, those of us who were the contemporaries of Eugene Caldwell felt that no one other than Preston Hickey could have so clearly conveyed to the mind of the younger physician the significance of Dr. Caldwell's professional career, and the influence it continues to exert on the growth of roentgenology.

Dr. Hickey's relation to the younger physician is peculiarly close, not alone because of his position as a teacher and a mentor, but because he himself chooses to remain young. To transcend the years is really a matter of one's own choosing. The son of the Reverend Manasseh Hickey, he was born in the State of Michigan in the year—well, in one of the years of bumper crops! He was reared and educated in Michigan, married a daughter of Michigan, and has continued his career as a practitioner and a teacher within the confines of Michigan, except as he has gone forth to serve his Country and her Allies.

It is known that such close adherence to the branches of one's vine and figtree tends, in some individuals, to create a provincial circumscription of vision and consequent mental stenosis. Why not so with Professor Hickey? Largely because his influence is swept beyond his finite boundaries by his migrating disciples, with whom he has maintained such sympathetic contact. Although a fruit of the pedagogic tree, he has not allowed its foliage to inhibit, in the shade of pedantry, his development; and so he continues to ripen and to mellow without decay.

Therefore, while it were perhaps out of place to inject here even a passing breath of politics, I cannot help venturing the opinion (and I say it within the sovereign State of Missouri and knowing him to be a Democrat) that, measured by everything except the weight of years, Preston Hickey may well be called with pride and affection, the "Grand Old Party" of American Roentgenology!

His services to this Society have been signal ones, and they go deeper than many of you realize. Back in the first years of this century, our Society was as a ship sorely beset by unfavorable winds. They were the winds of commercialism, and bade fair to drive us on the rocks. But with Lester Leonard at the helm and sternsheets and Hickey at the foresheets and halyards, we found the calm and deep water we now occupy.

* An account of this presentation with remarks by Dr. Brown was published in the November, 1928, number of the Journal. It seems particularly fitting, however, to republish it in this number. The Caldwell Lecture by Dr. Hickey also appears in this issue.—Ed.

## Preston M. Hickey, 1865-1930

Preston Manasseh Hickey! Skilful practitioner; respected teacher; authoritative writer; patient demonstrator; champion of stabilized thought and calm diagnosis; personification of patriotism and efficient medical officer overseas; able president of this Society and worthy spokesman for American Roentgenology abroad.

It becomes my happy privilege to stand before you as a mouthpiece for the American Roentgen Ray Society. The Society could have selected no one who would have more willingly expressed its affection for you. I am charged with the agreeable duty of presenting to you, in its name, a material token of this affection, which I now do with infinite satisfaction. The laws relating to standards require that, upon each piece of this service shall be stamped the word "sterling." How fortunate and how appropriate, for this is the exact word that has been stamped upon your character by all who know you.

I have little knowledge of the constructive art of the silversmith, but I do know that this pitcher is a container for the milk of human kindness, of which you have such an abundant supply; and that this bowl is the receptacle for that saccharine substance so suggestive of your disposition.

So, as you sit at your tea in the evenings to come, may these polished surfaces reflect, as a background for the faces of your loved ones, the images of the many loving friends who now sit before you!

## Resolutions of the American Roentgen Ray Society on the Death of Preston M. Hickey

In the death of Preston M. Hickey the American Roentgen Ray Society has lost its most distinguished member and a leader who was a great constructive force in the development of roentgenology. He will be remembered in many capacities and deeply mourned by many comrades as a fellow radiologist, teacher, investigator, inventor, physician, diagnostician, writer, editor, soldier, administrator, adviser and friend. He was the father of our Society in its present form and the founder of our Journal. A rare combination of ability and learning with a genial nature and a generous interest in the work of others won for him to a preëminent degree the affectionate regard of the members of this Society and a very wide circle of roentgenologists throughout the world. His influence will continue to be felt as long as roentgenology is practised for the alleviation of human suffering.

To the bereaved family, we offer a sympathy which is the outcome of our own feeling of deep personal loss in the passing of such a comrade and friend.

Committee: George E. Pfahler
Harry W. Dachtler
A. W. Crane

## Resolutions of the Detroit Roentgen Ray and Radium Society

Whereas the death of Dr. Preston M. Hickey occurred on October 30, 1930, and

Whereas Dr. Hickey was the founder of this Society, its most eminent member and its chief support and inspiration since its organization, and

Whereas he brought renown to himself and to this Society by the excellence and multitude of his scientific productions and by his unsurpassed ability as a teacher and practitioner of our profession, and

Whereas his unending enthusiasm and interest in his life work was a constant example for our membership, and his incessant care and utmost patience and sympathy with the afflicted, a pattern for our conduct, and

Whereas he was at all times to some or all of us teacher, associate, companion and friend, enriching our lives in every contact, be it therefore

*Resolved* that his death be recorded in the minutes of this Society with a sentiment of high regard for his memory and a deep sense of loss to all members of this Society, and be it further

*Resolved* that a copy of this memorial be published in the *American Journal of Roentgenology and Radium Therapy* and in *Radiology*, and a copy be sent to his family, with the sympathy of the Society.